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Shimizu et al.

(54) **MOTOR AND ENDOSCOPE PROBE EQUIPPED WITH MOTOR**

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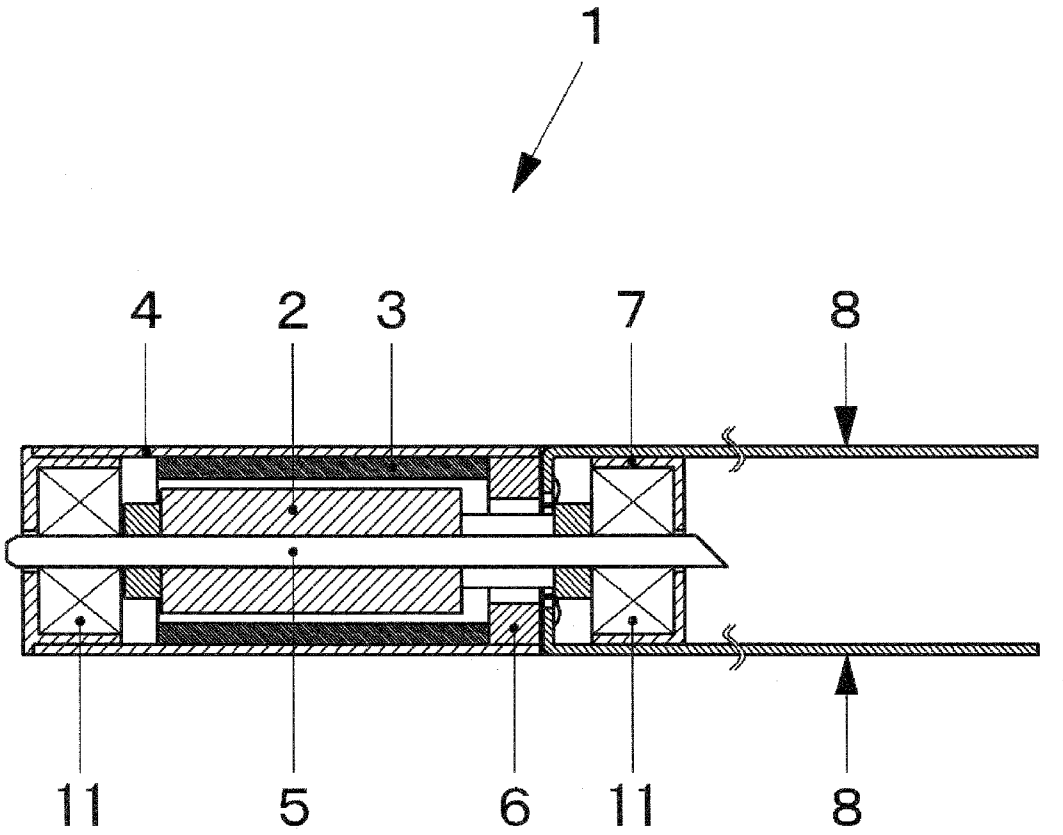
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H02K 7/116	(2006.01)

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(57) **ABSTRACT**

A motor which can be mounted in an endoscope probe without bending an electric power supply wire in an endoscope probe body, and an endoscope probe using the motor are provided. The motor includes a magnet, a field coil, a housing, an electric power supply wire, and a shaft. A lead wire from the field coil is connected to the electric power supply wire. A cutout is provided in a housing end, and the electric power supply wire is received along the cutout and led out to the outside of the motor in the direction in which a shaft projects. When the motor is mounted in the endoscope probe, the motor is placed in the endoscope probe body so that the shaft projects in the direction opposite to the direction of the front end of the endoscope probe, and the electric power supply wire, which is led out to the outside of the motor, is routed along the longitudinal direction of the endoscope probe.



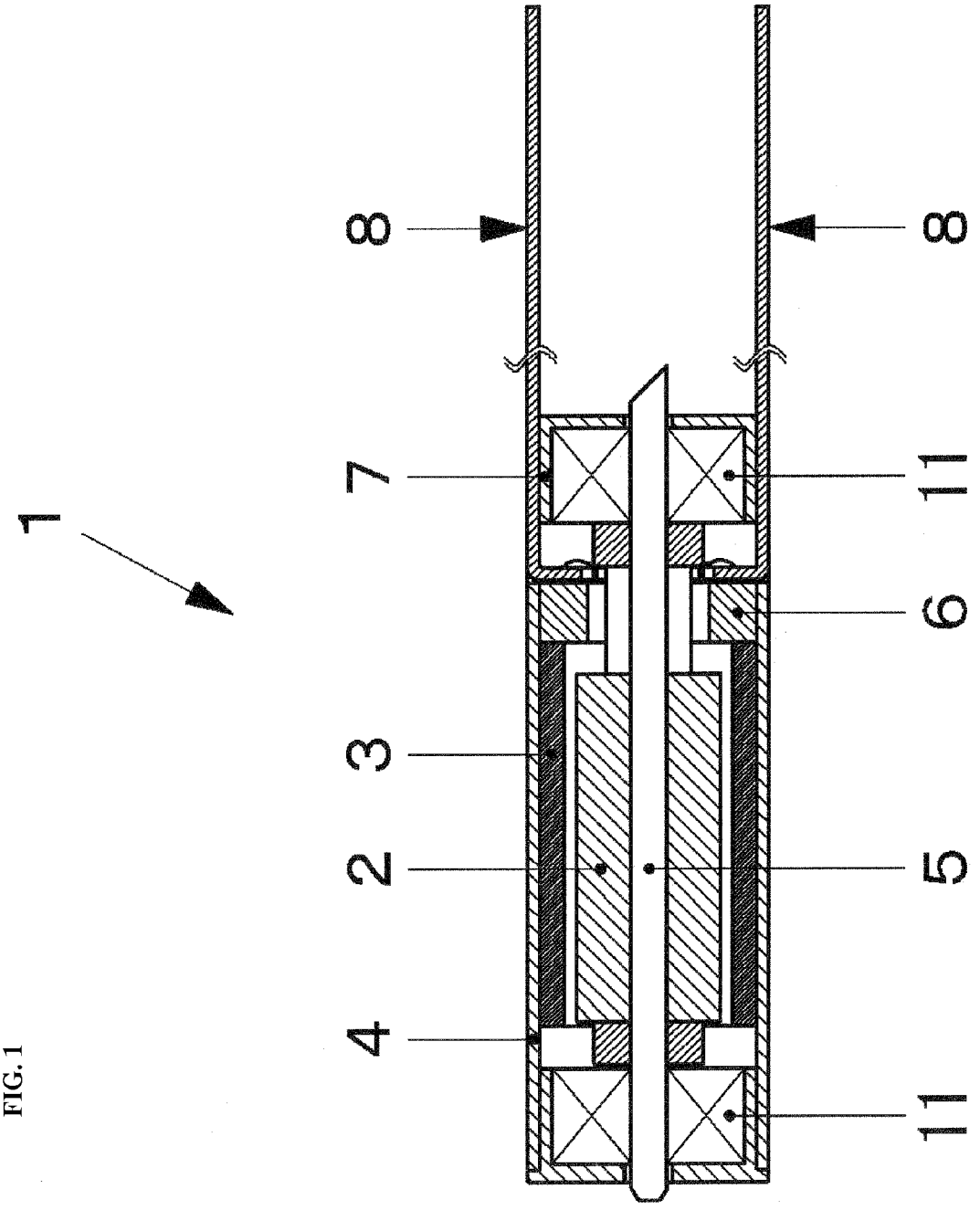


FIG. 1

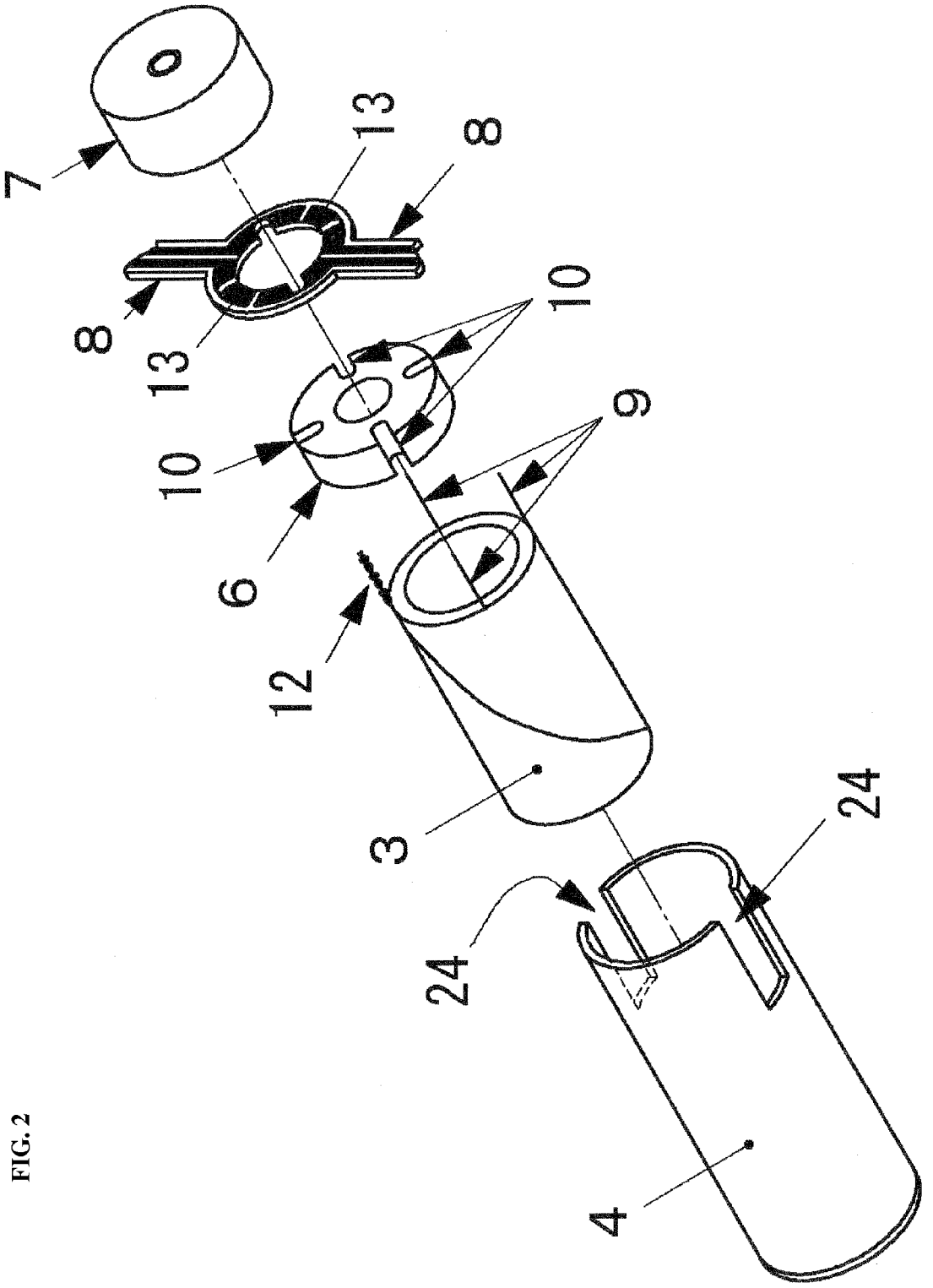


FIG. 2

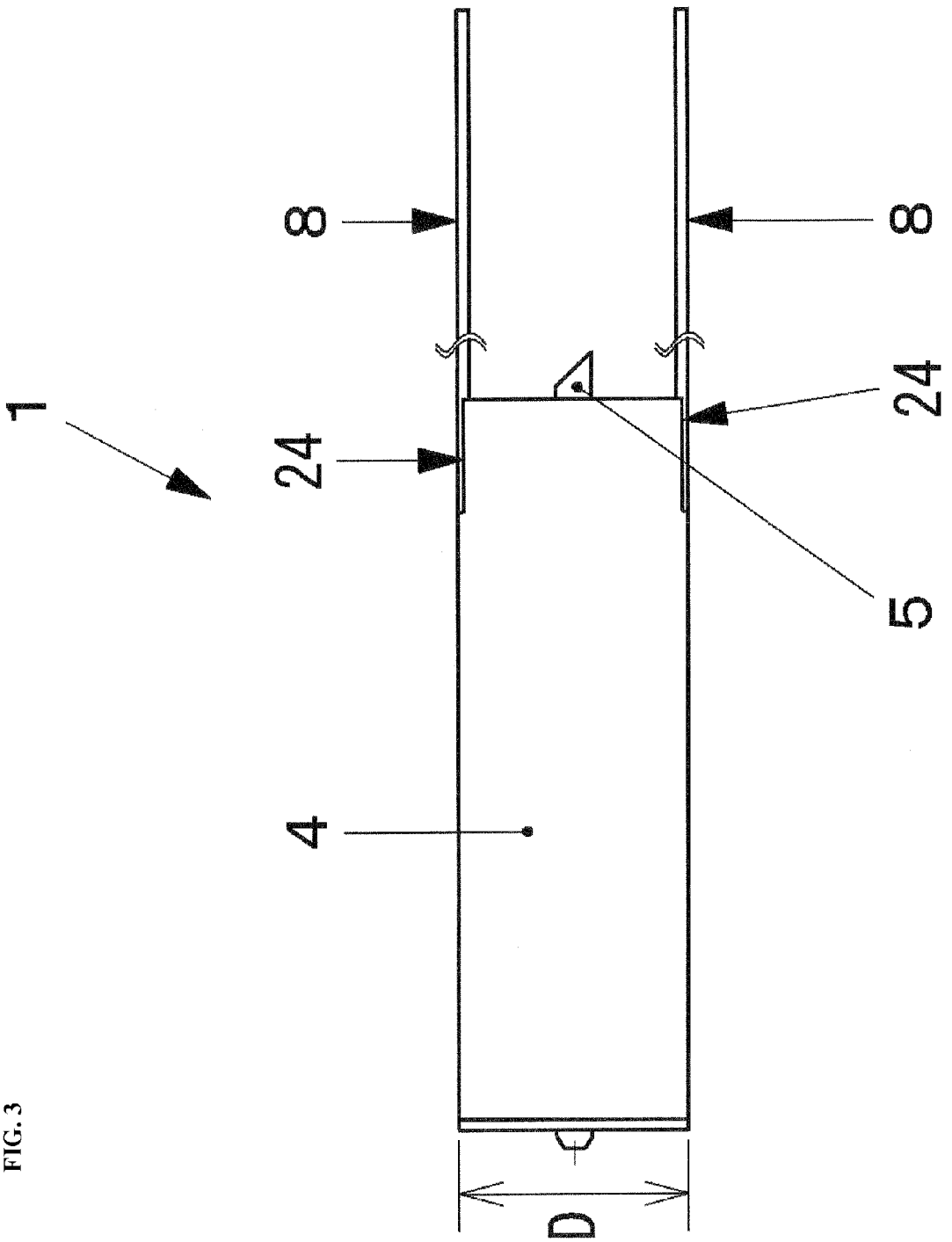


FIG. 3

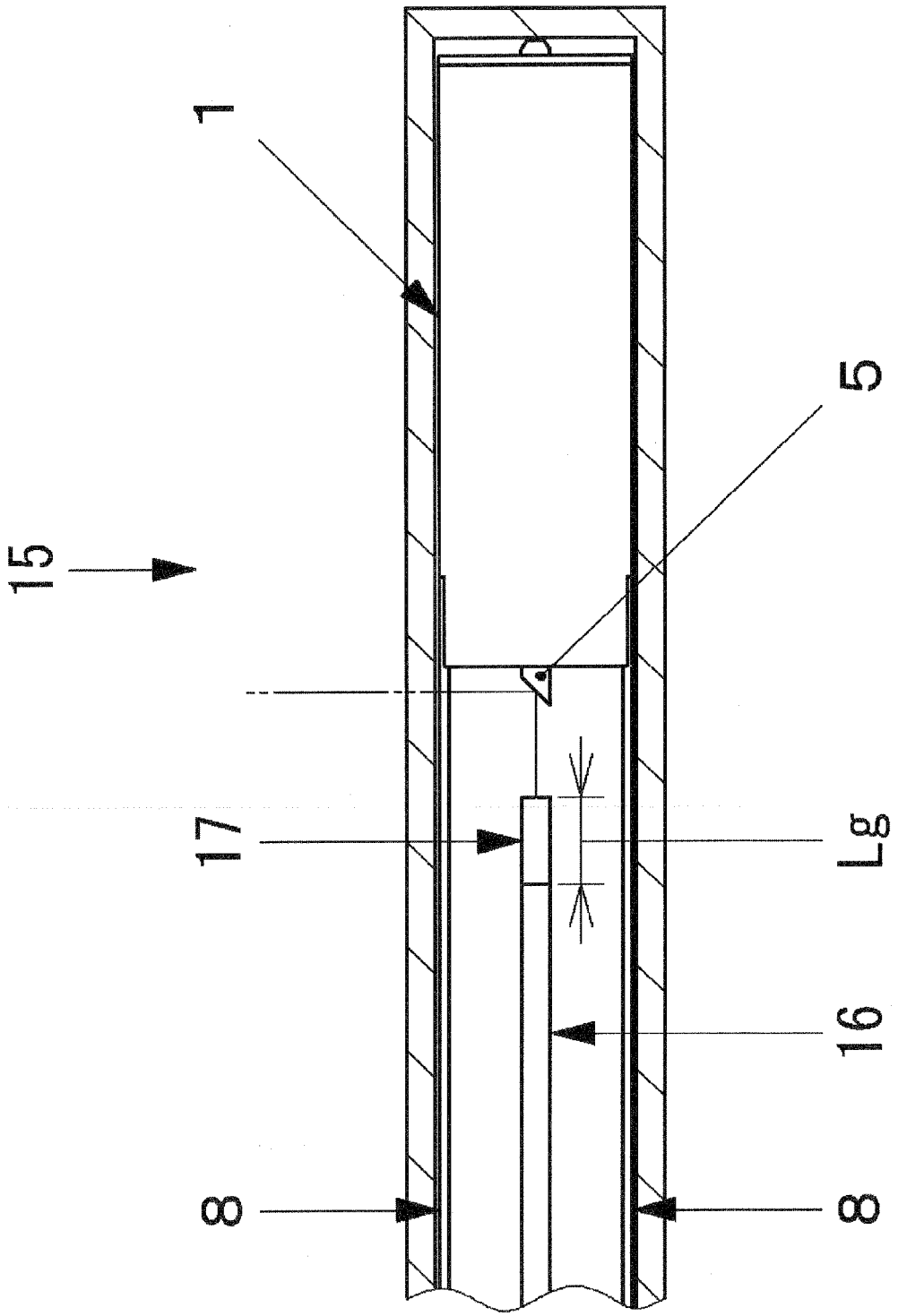
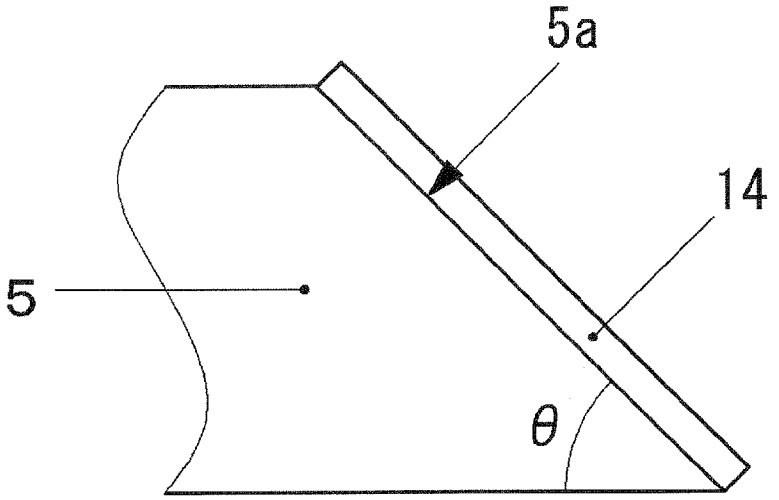
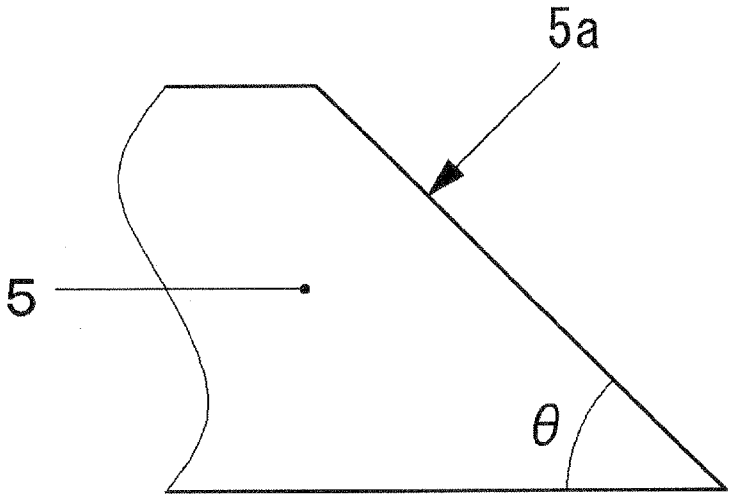


FIG. 4

FIG. 5



(a)



(b)

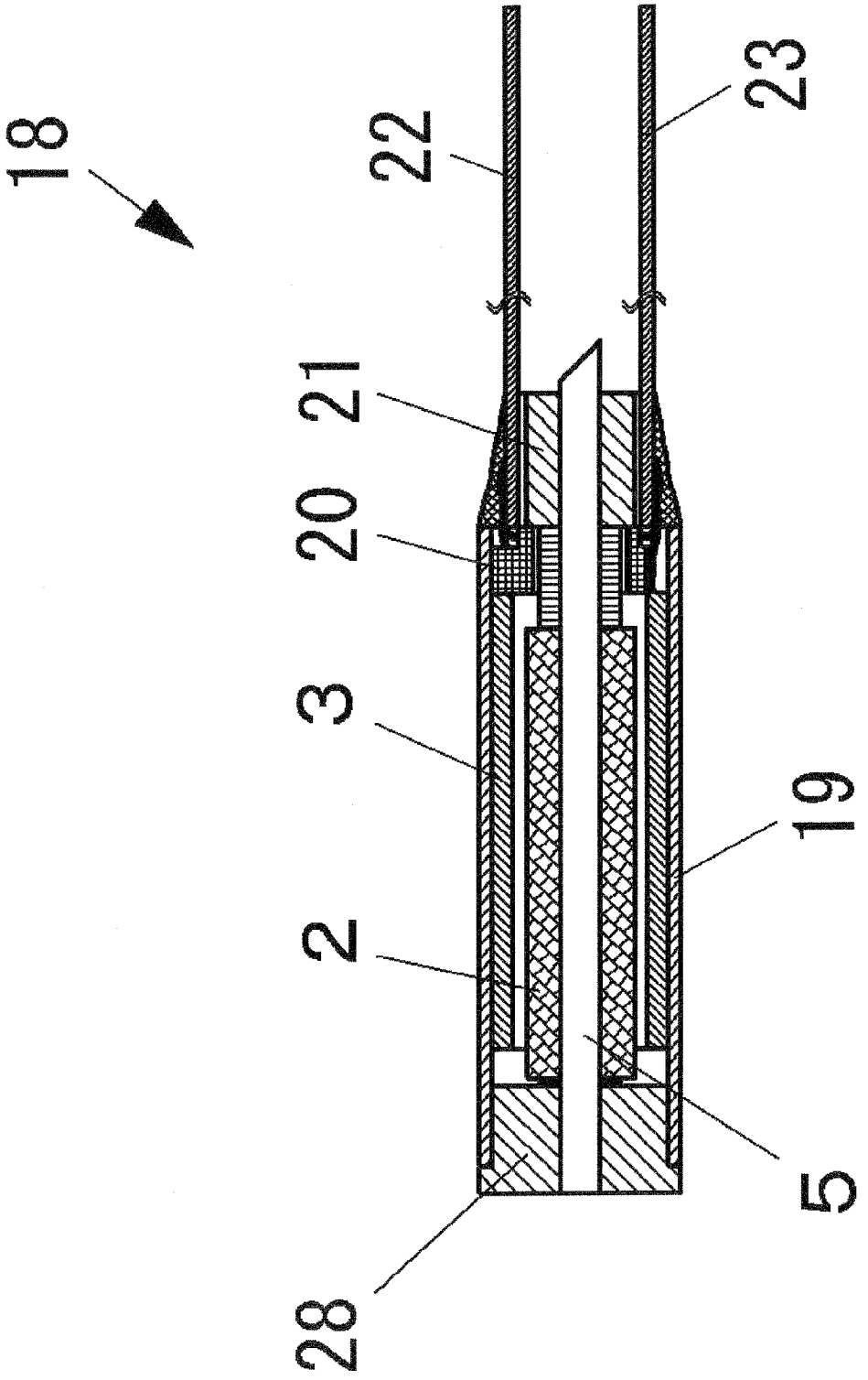


FIG. 6

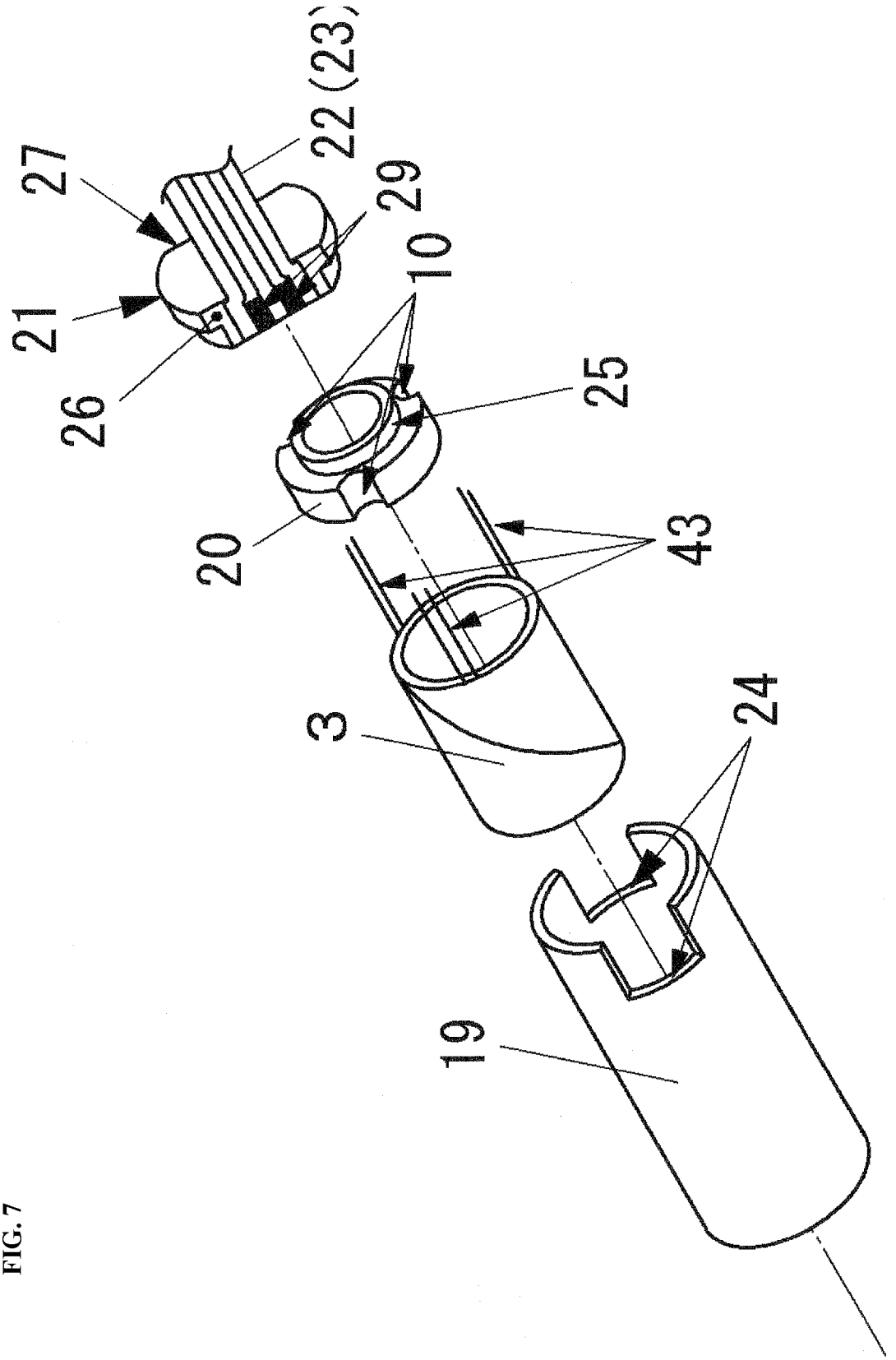


FIG. 7

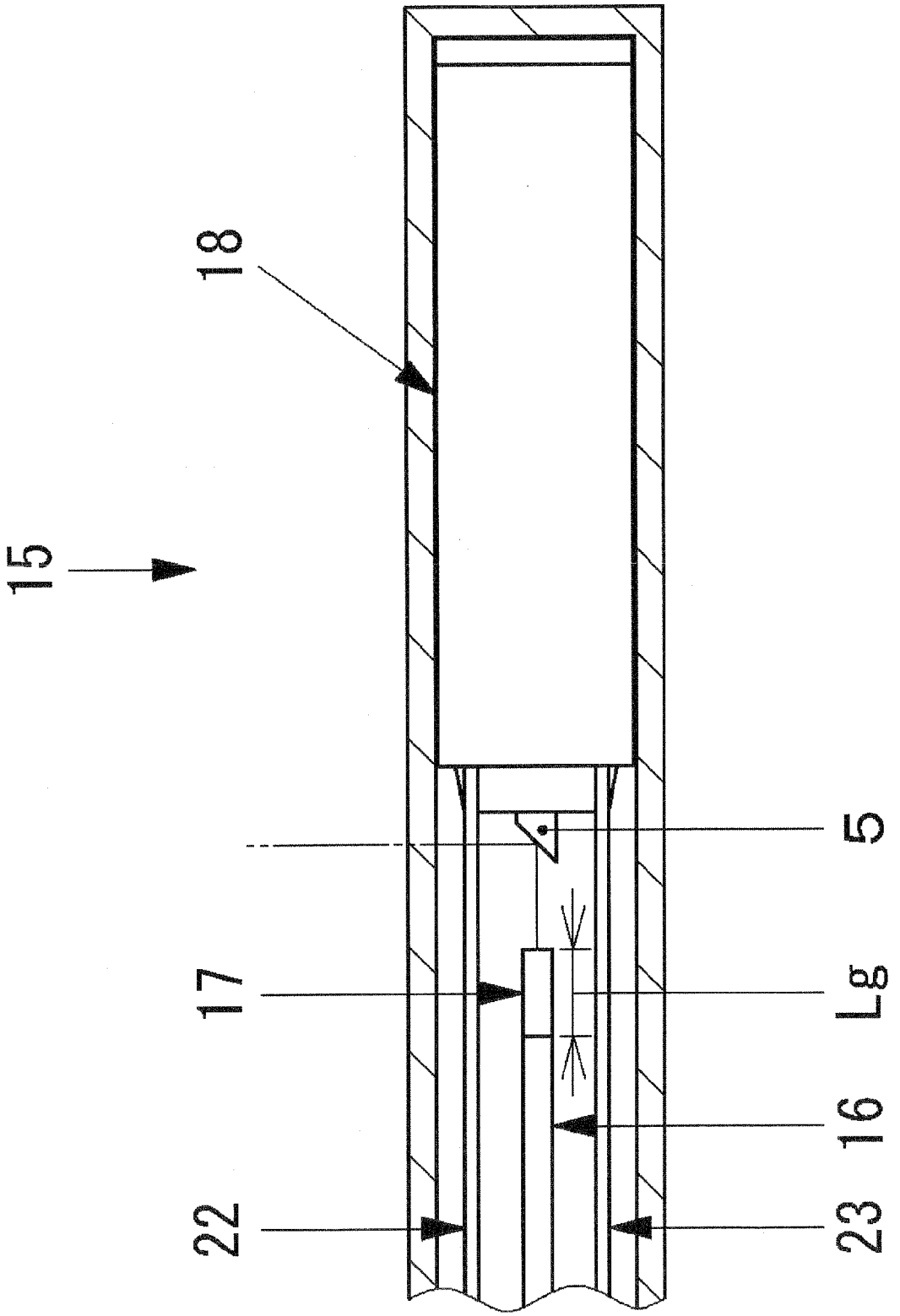


FIG. 8

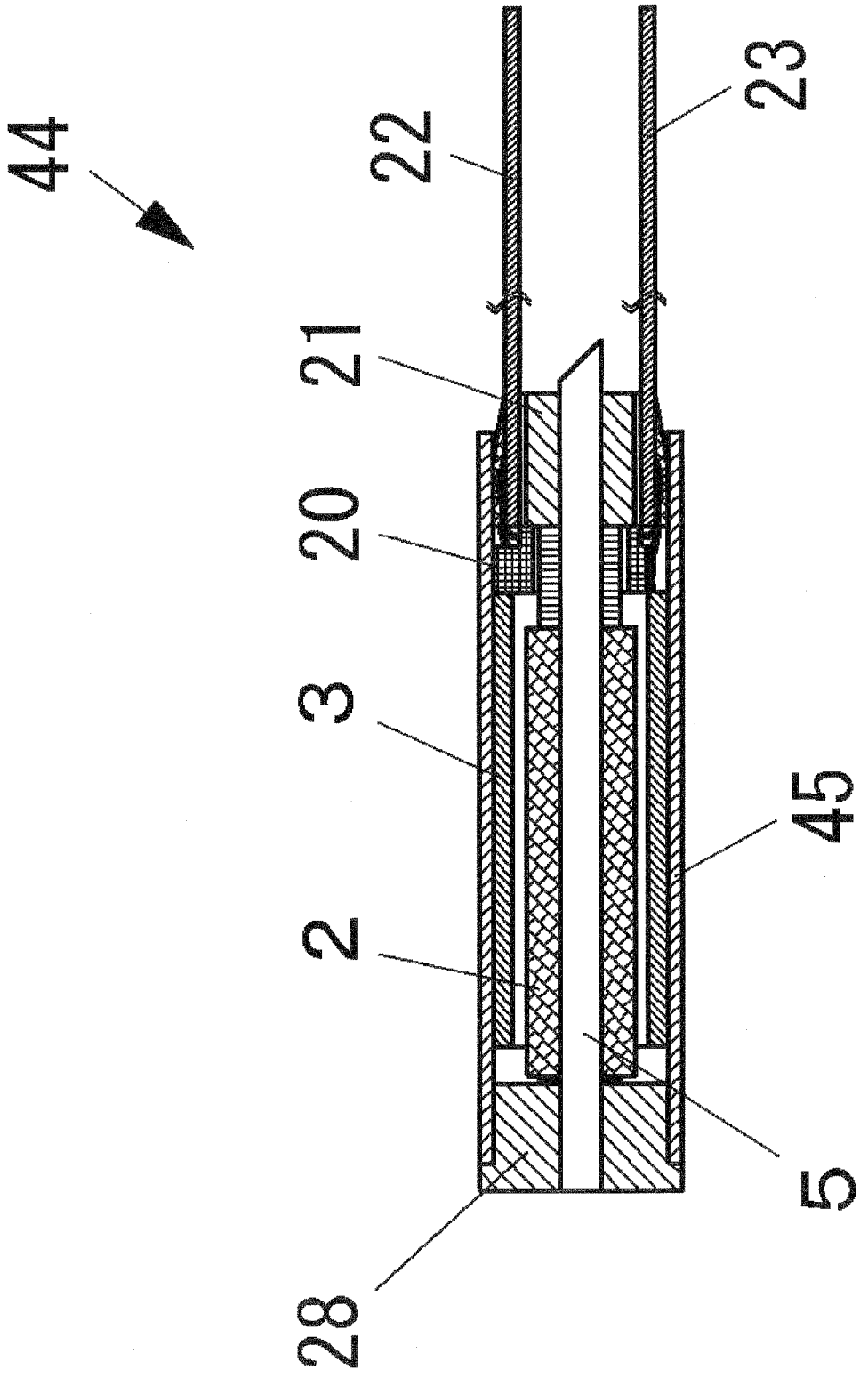


FIG. 9

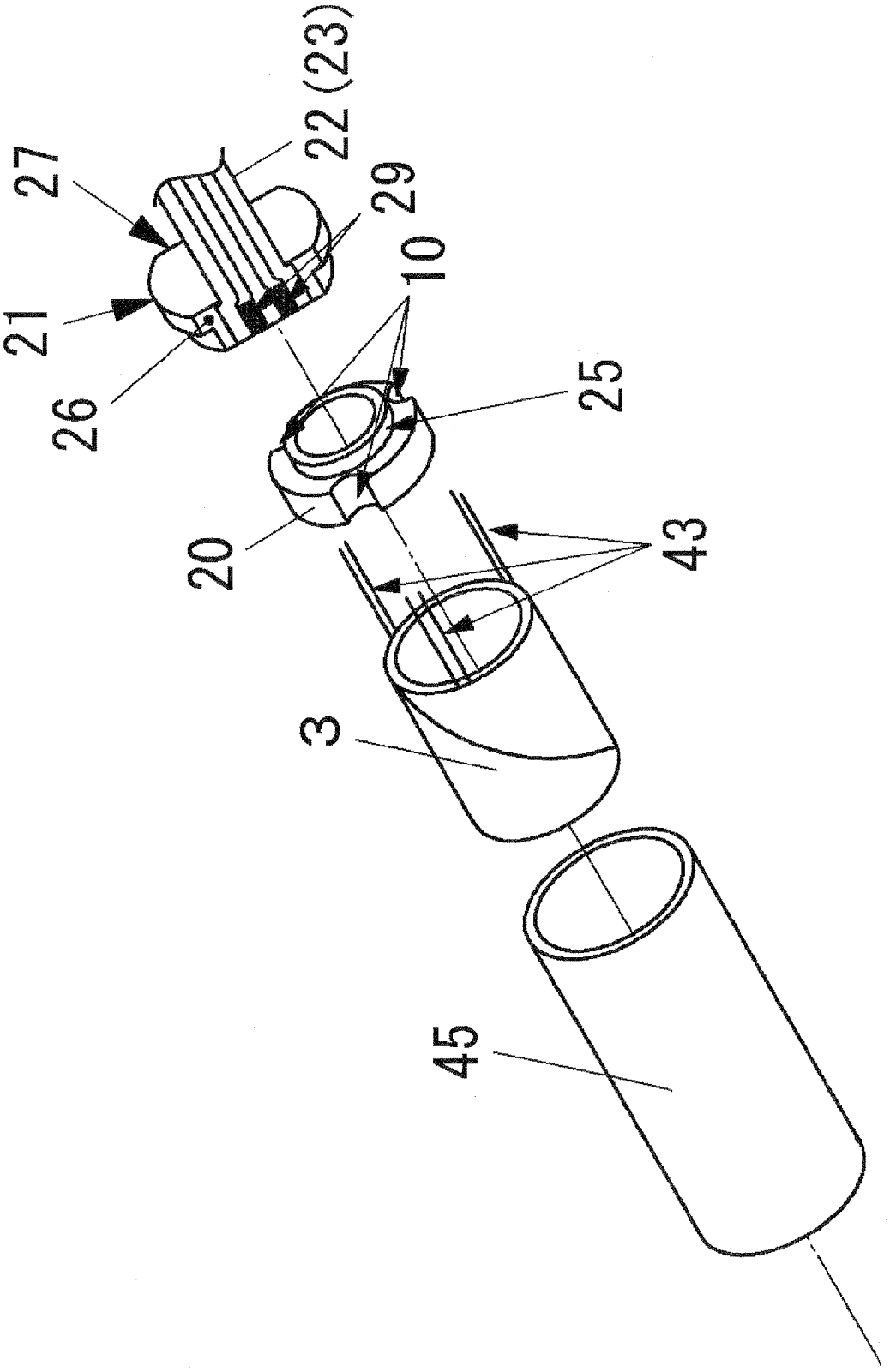


FIG. 10

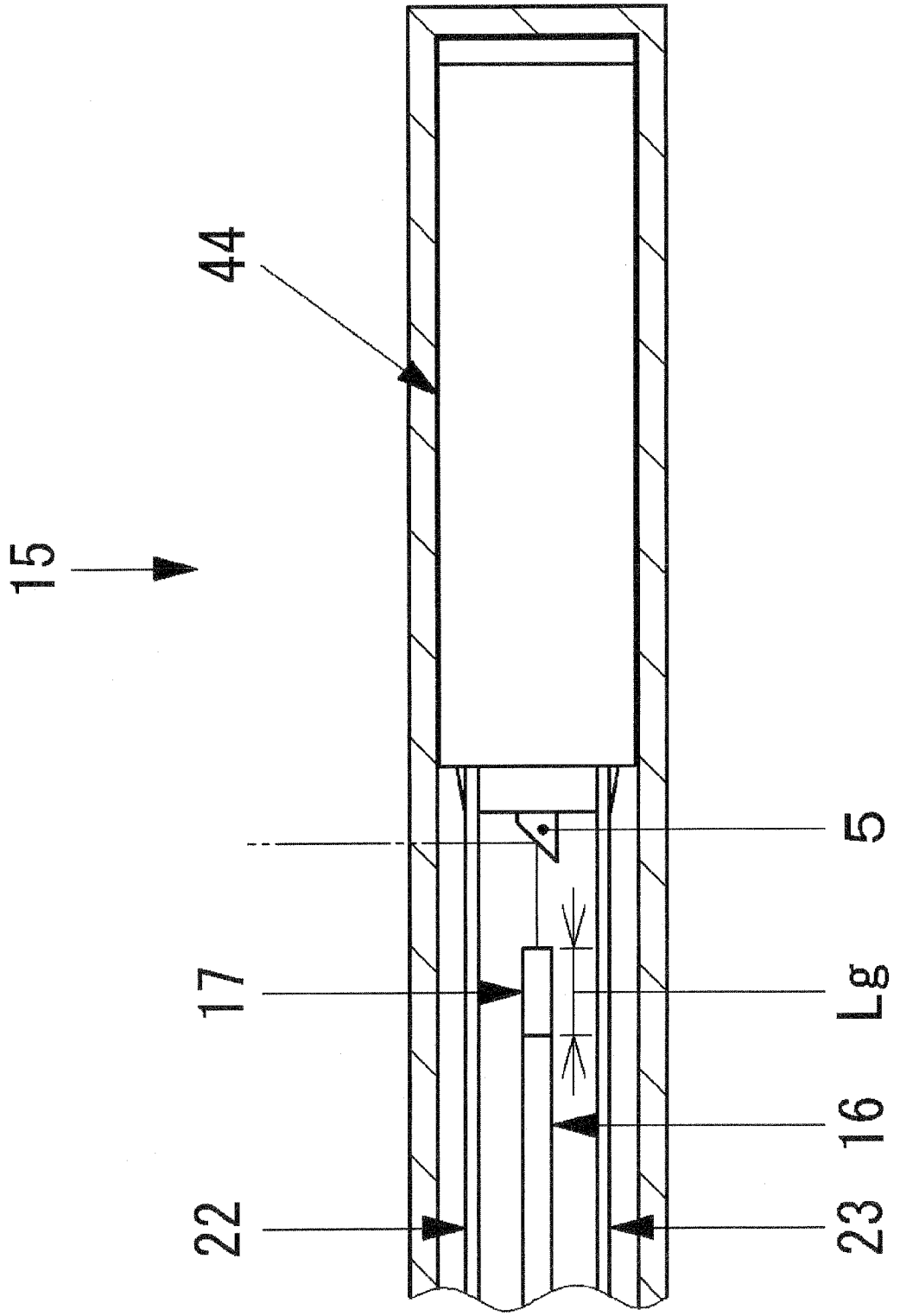


FIG. 11

FIG. 12

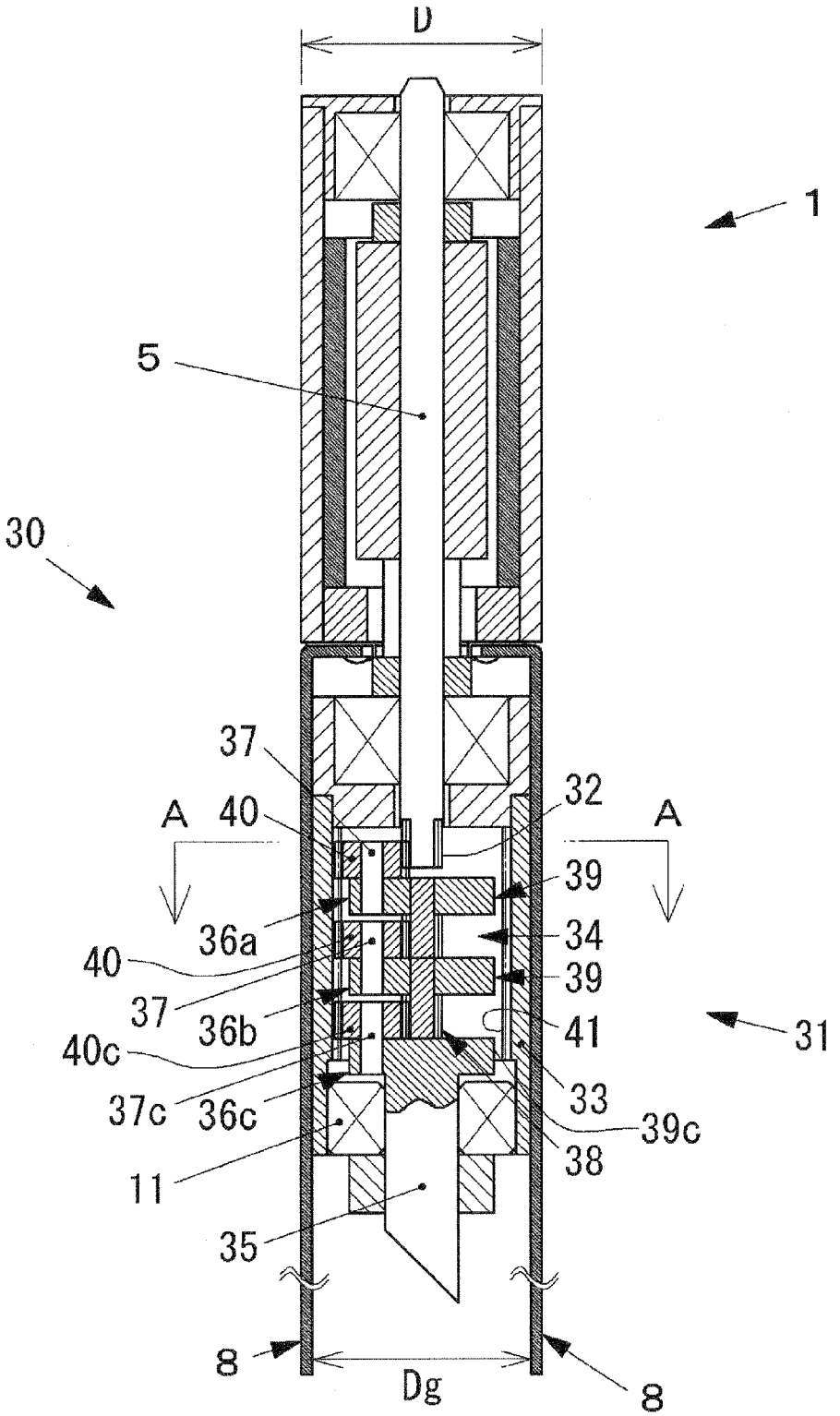
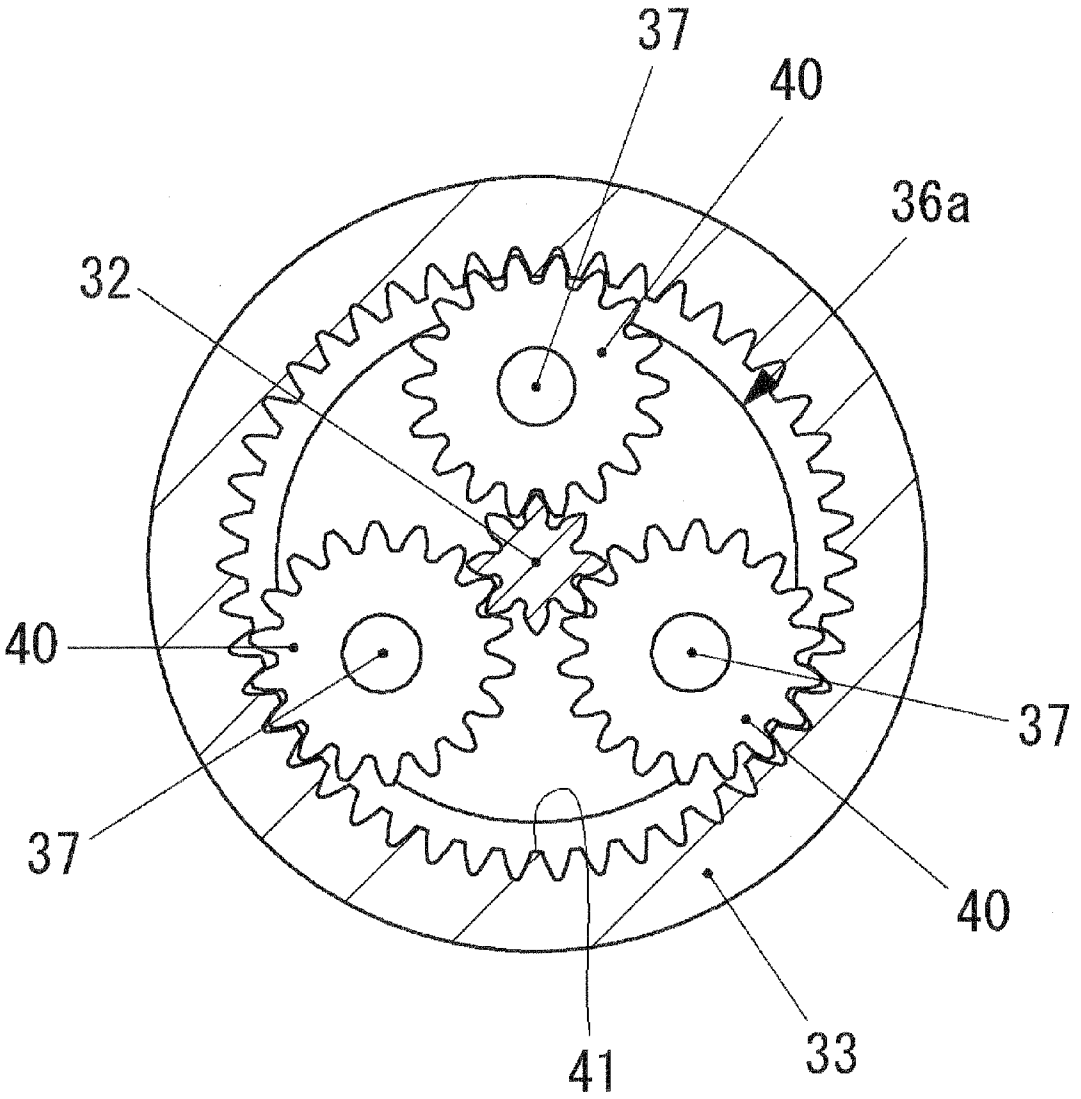

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FIG. 13



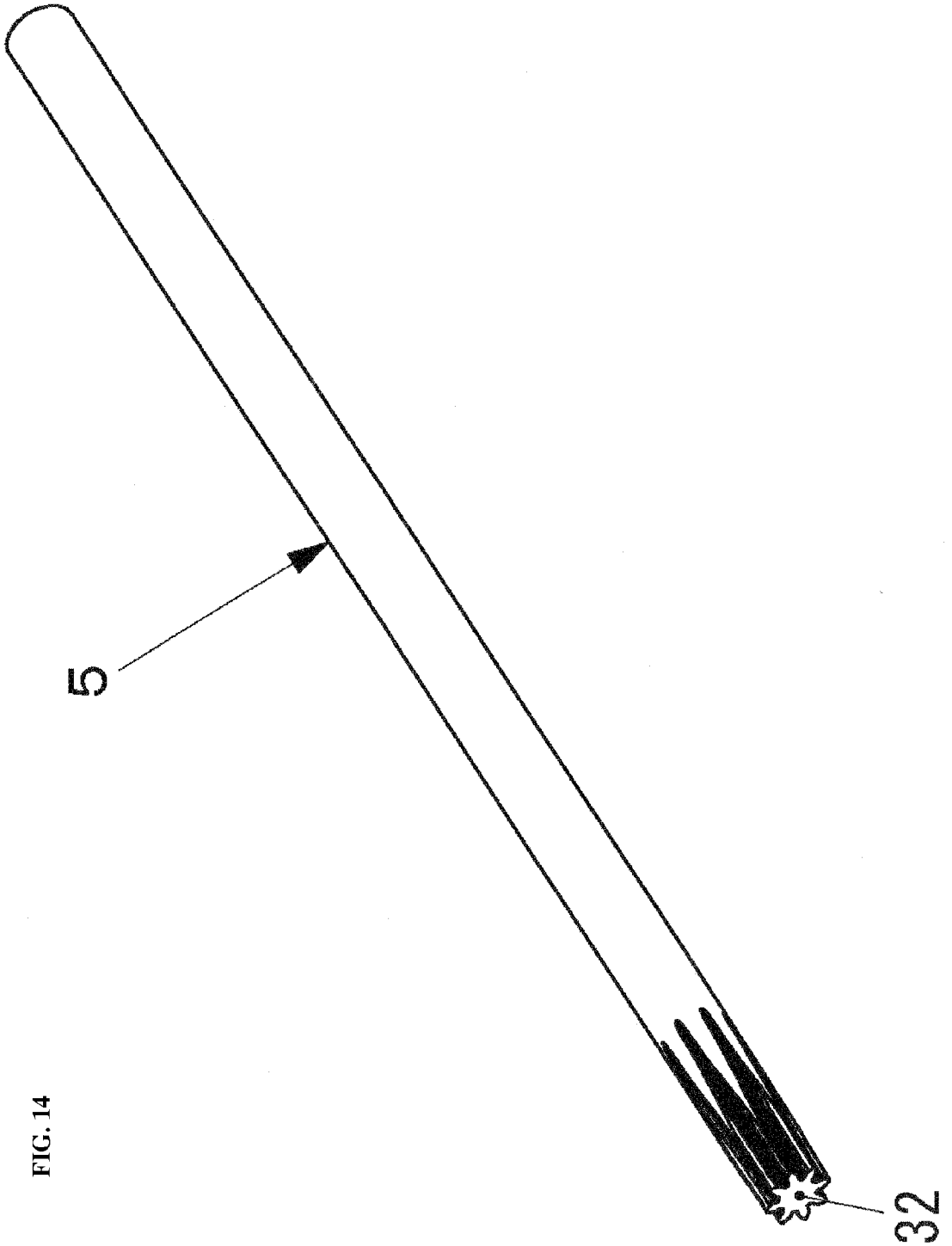


FIG. 14

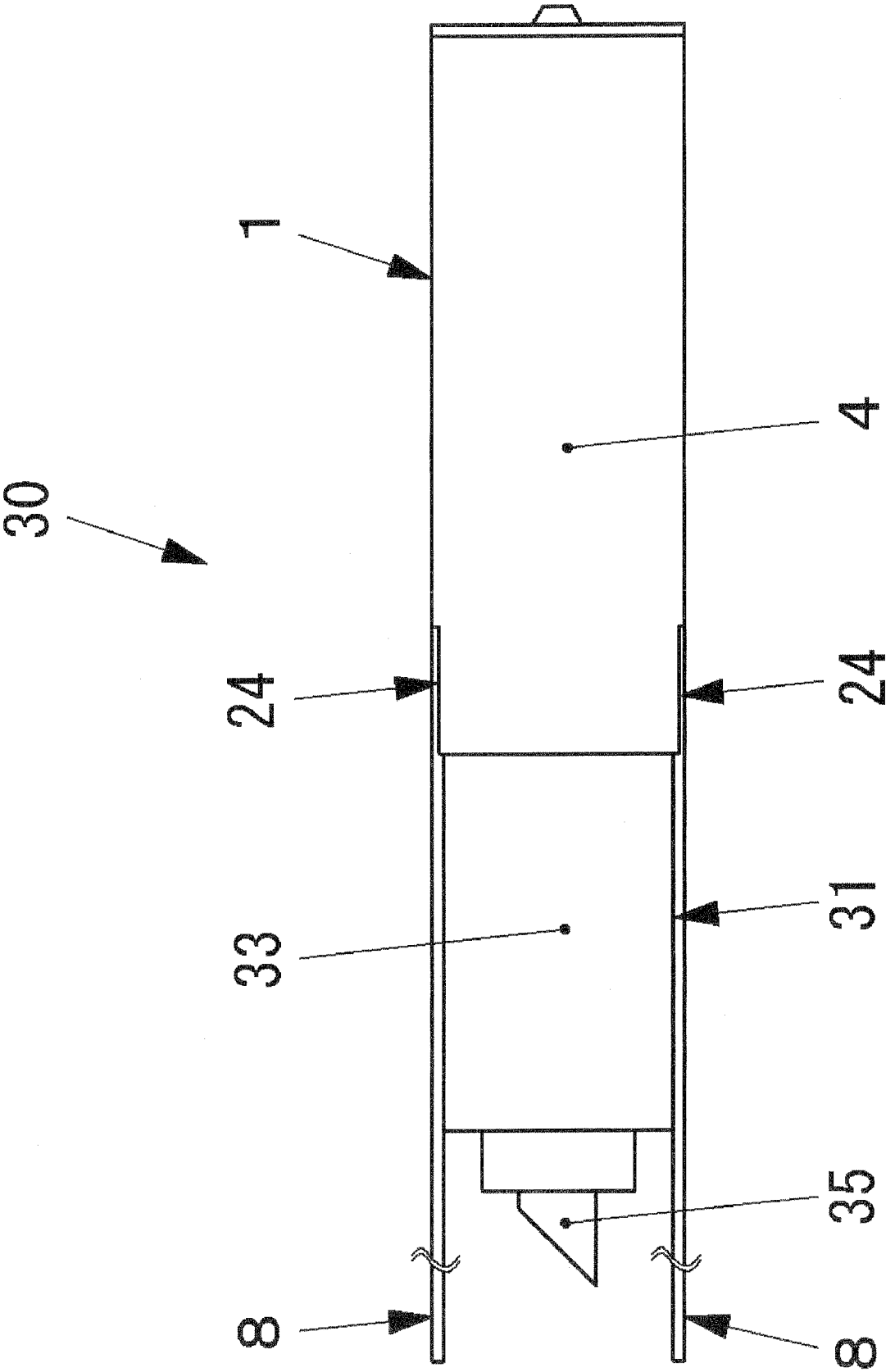


FIG. 15

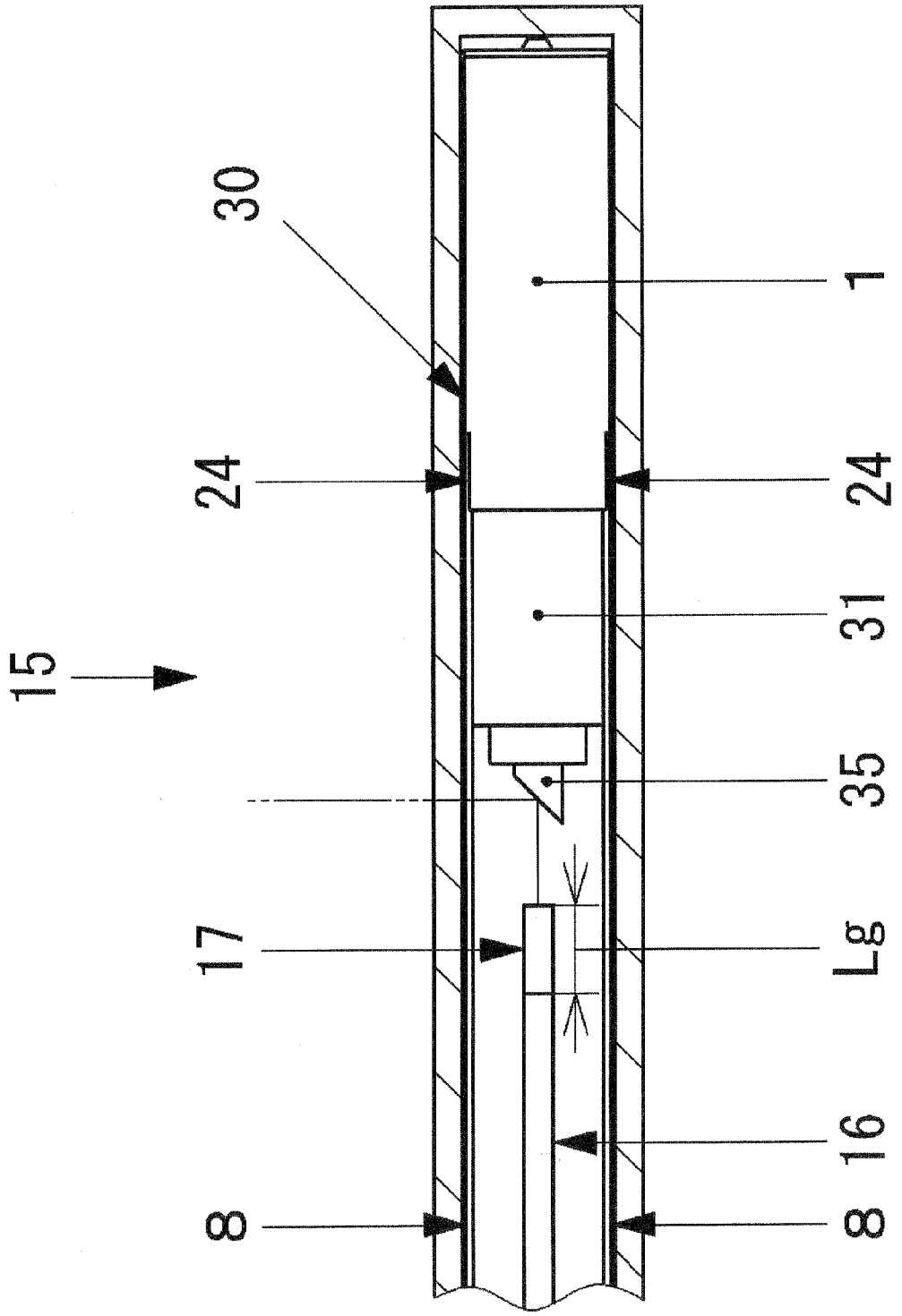


FIG. 16

FIG. 17

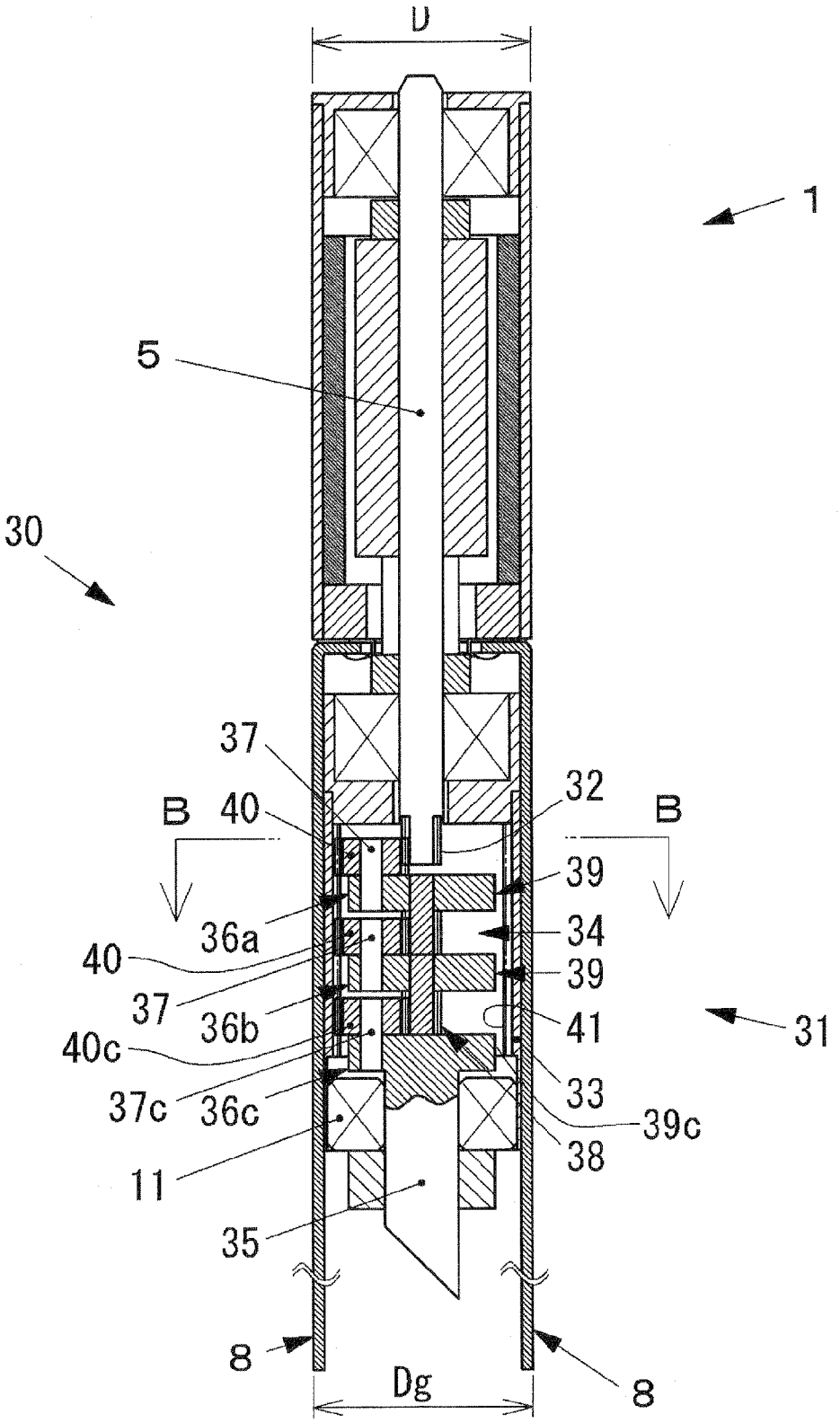
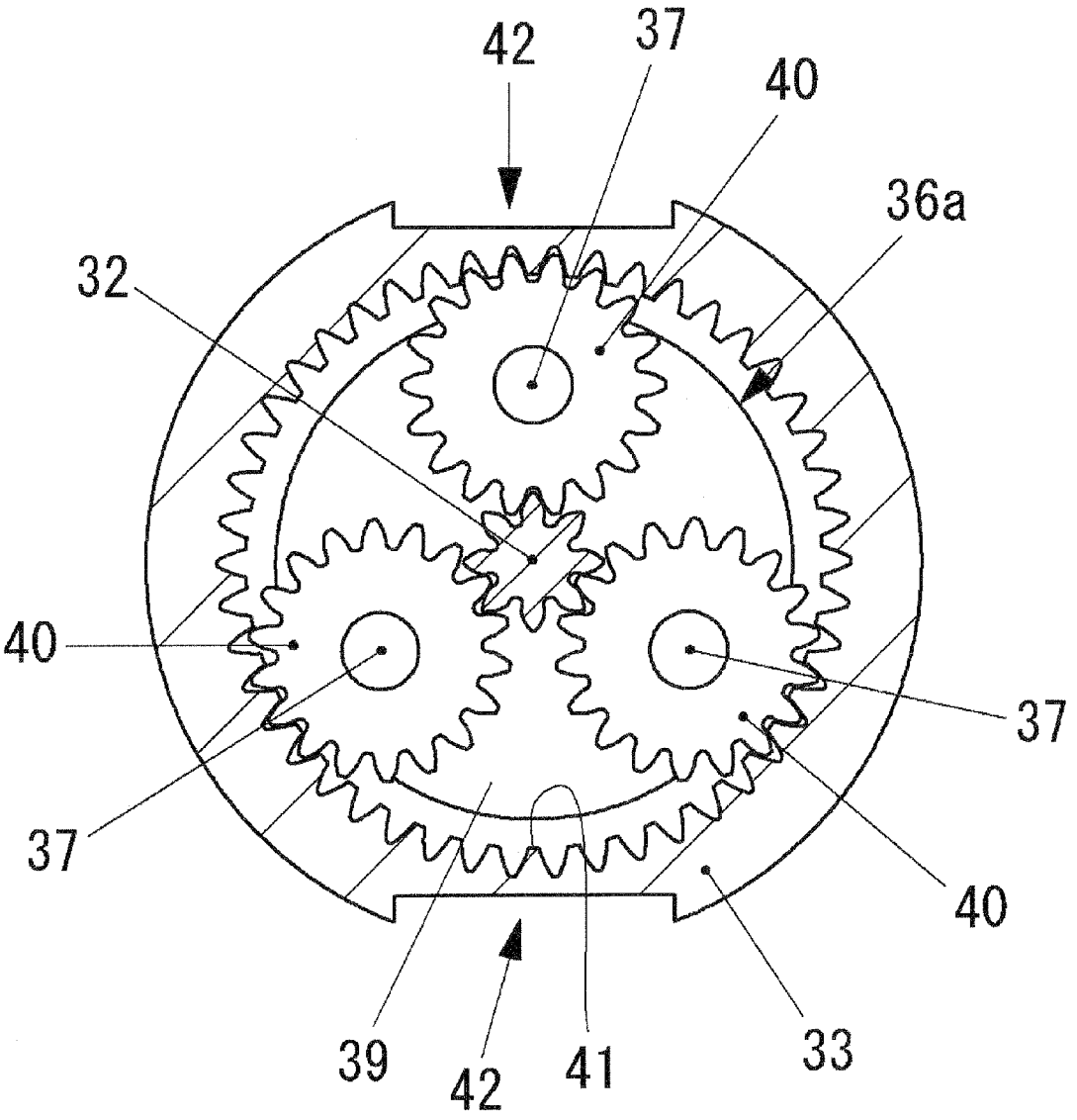

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FIG. 18



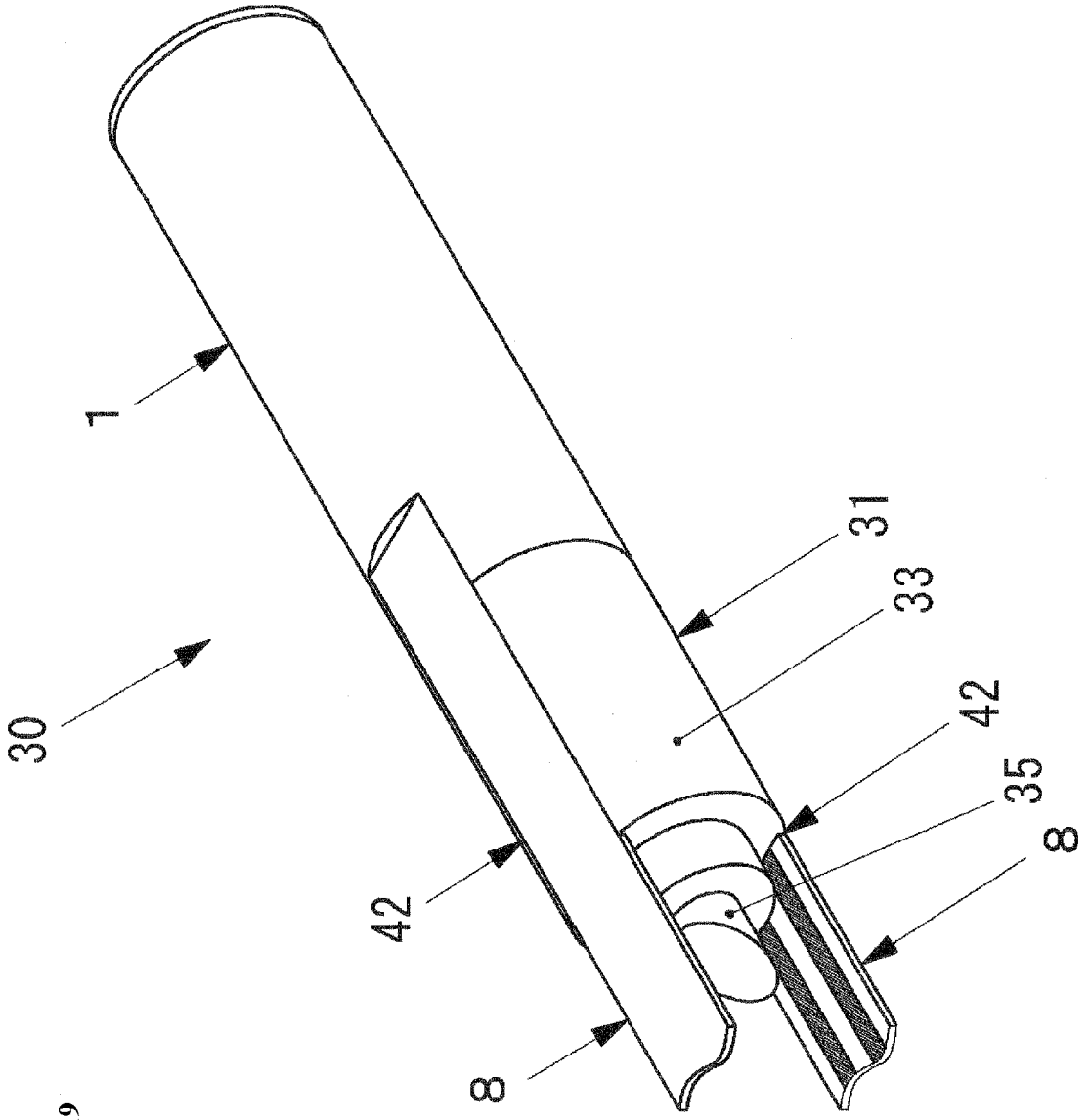
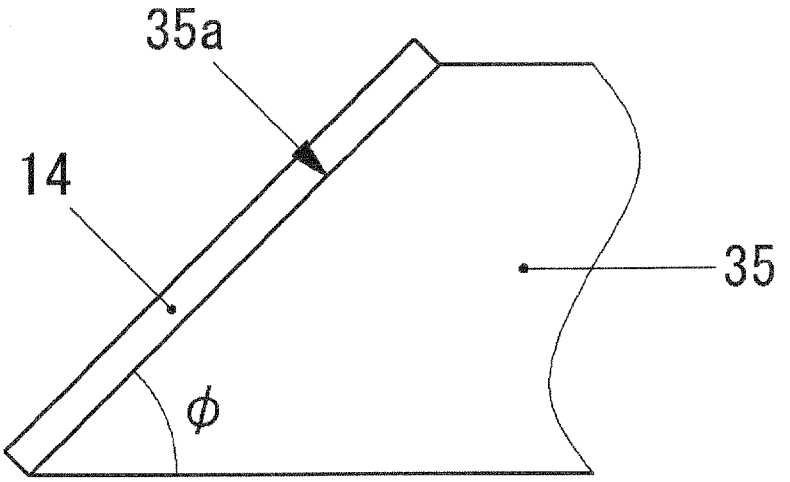
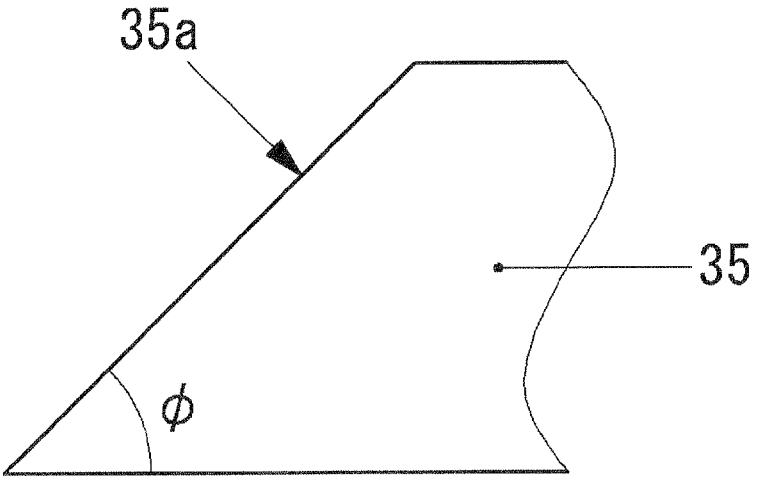


FIG. 19

FIG. 20



(a)



(b)

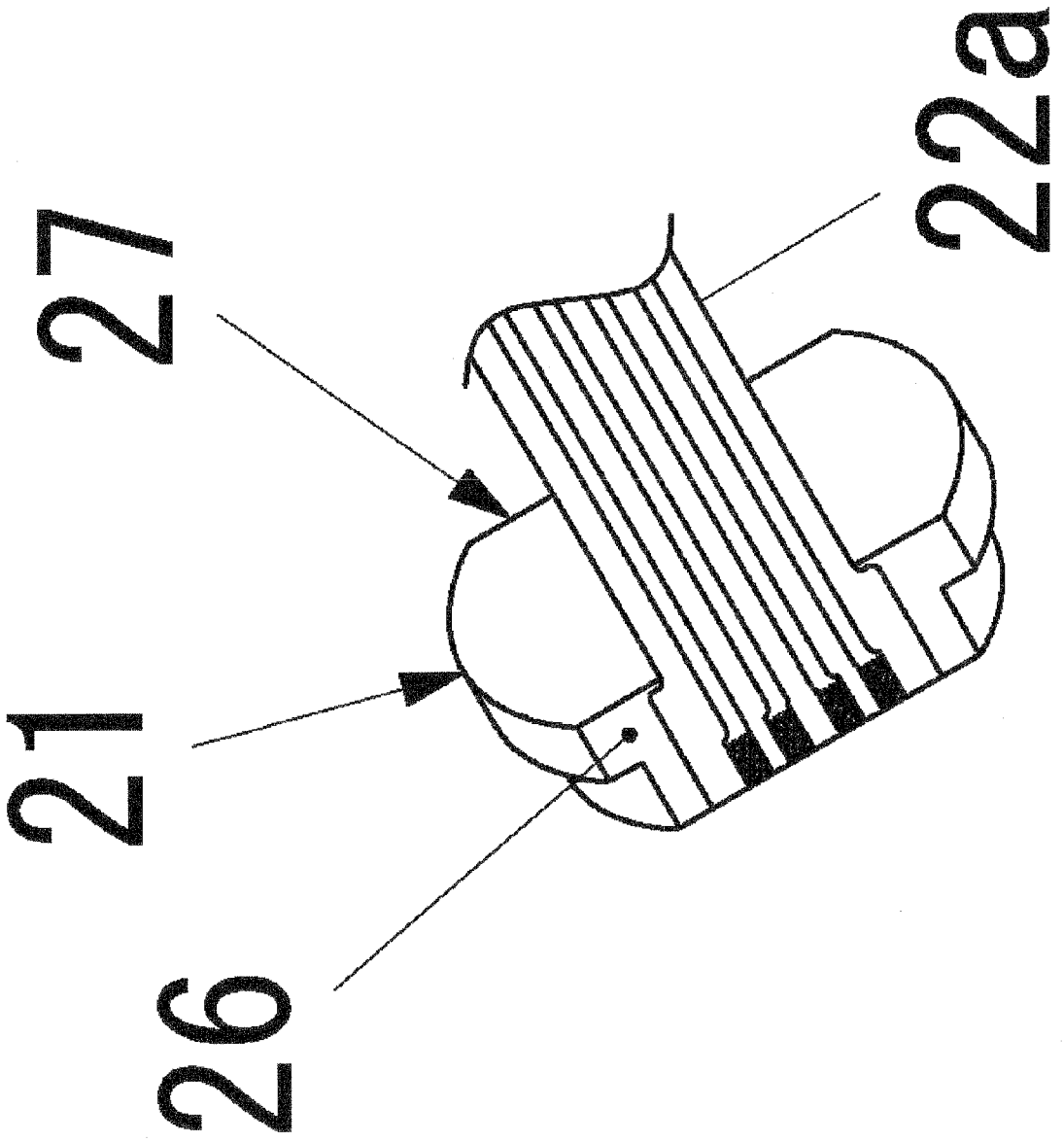
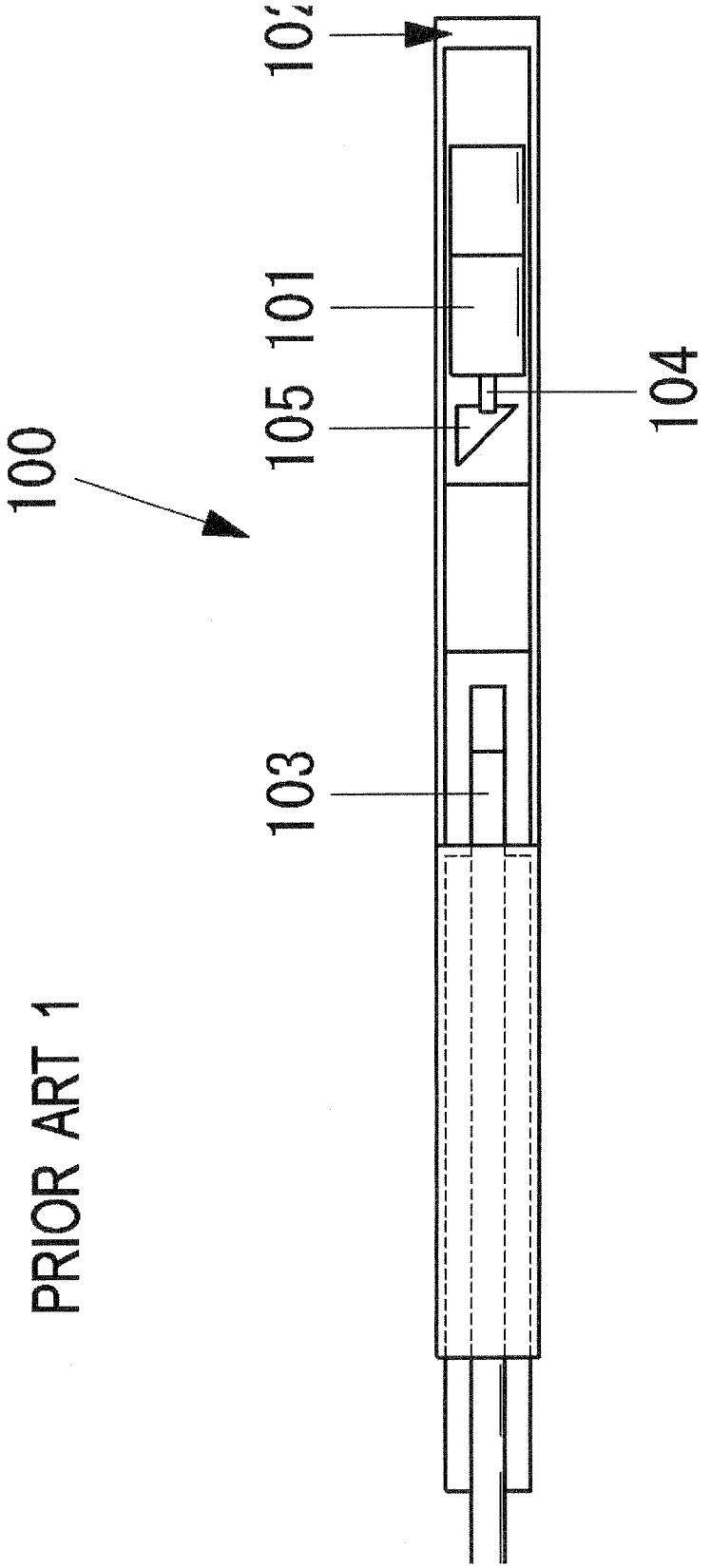


FIG. 21



PRIOR ART 1

FIG. 22

FIG. 23

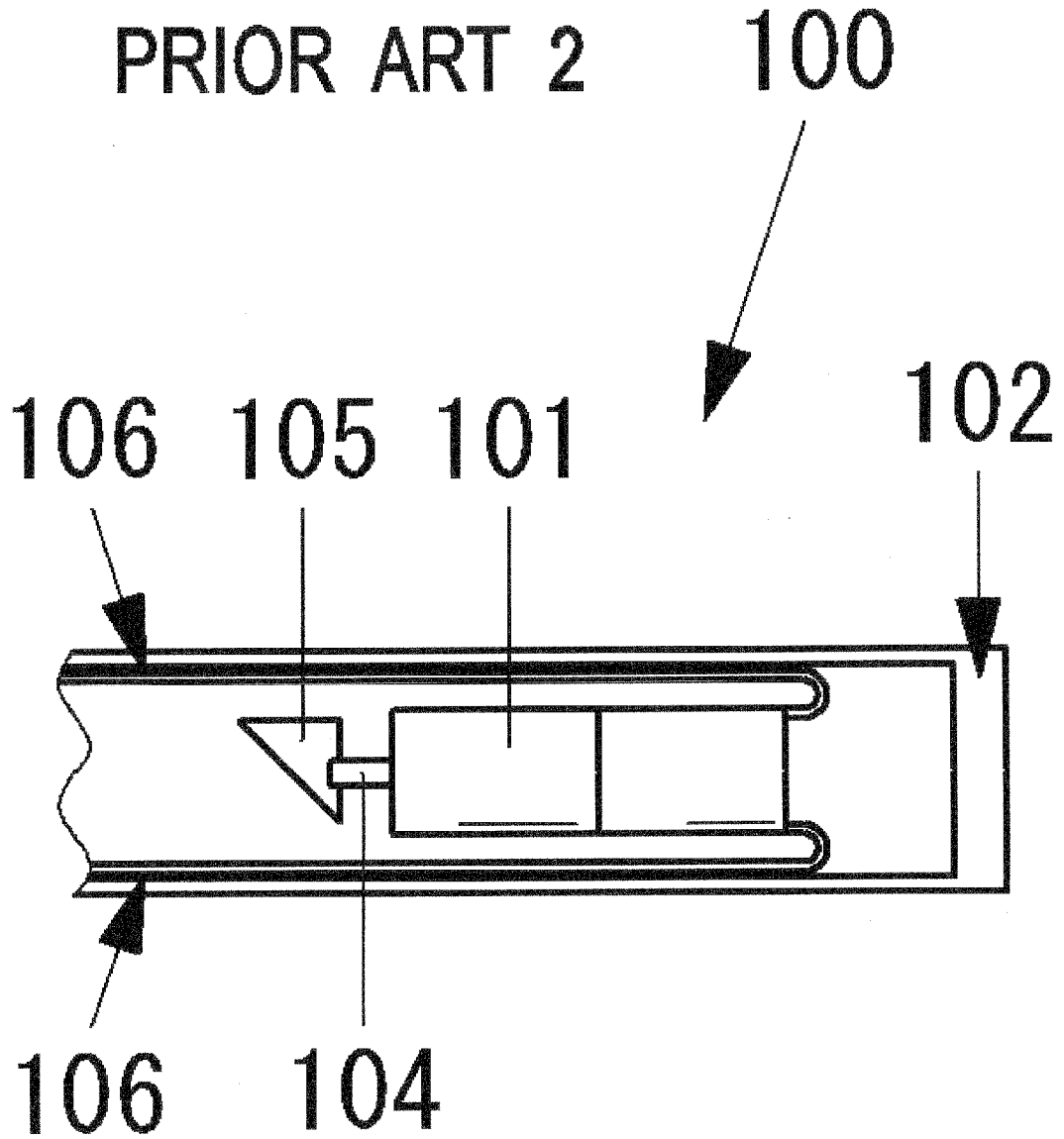
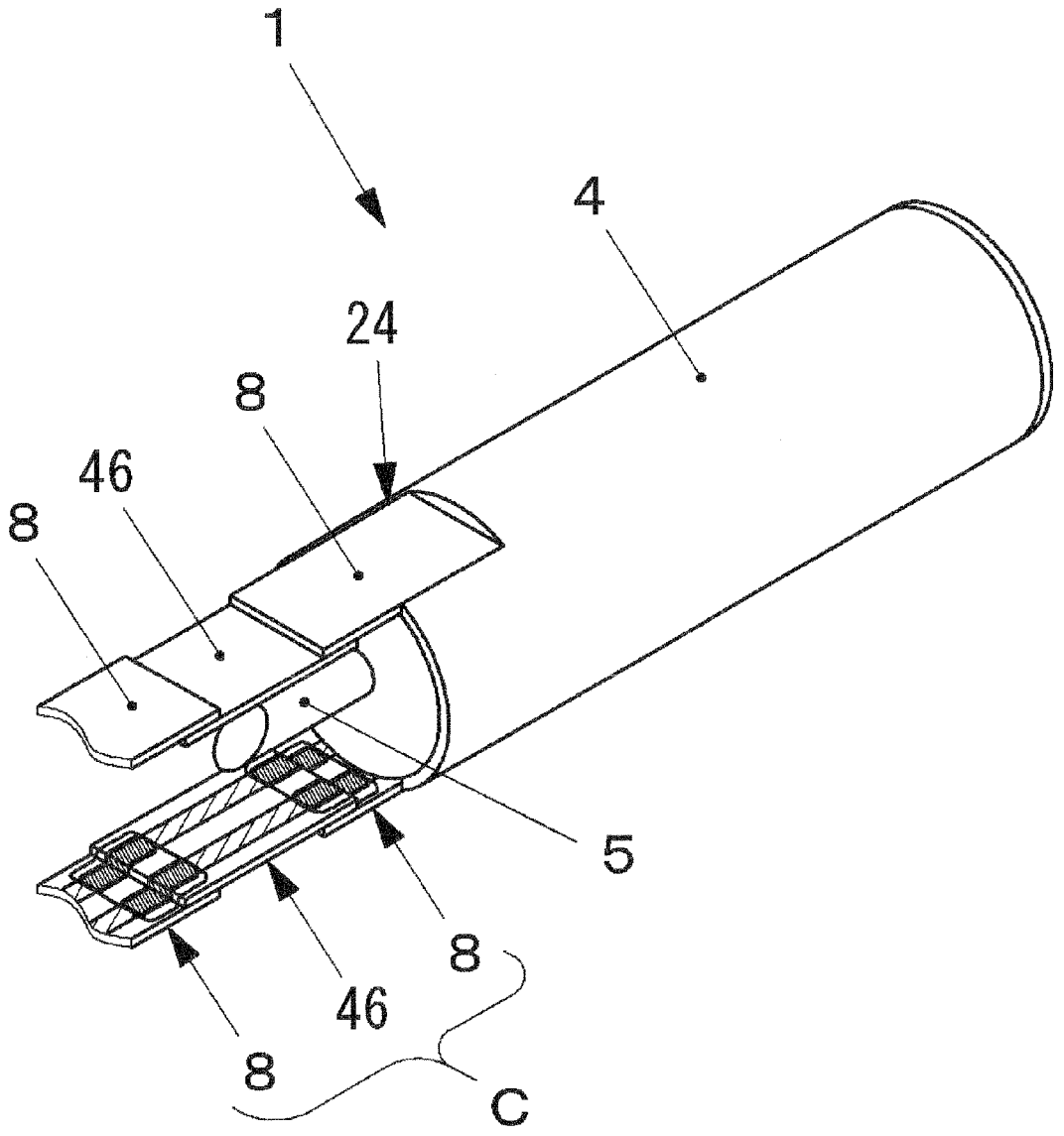


FIG. 24



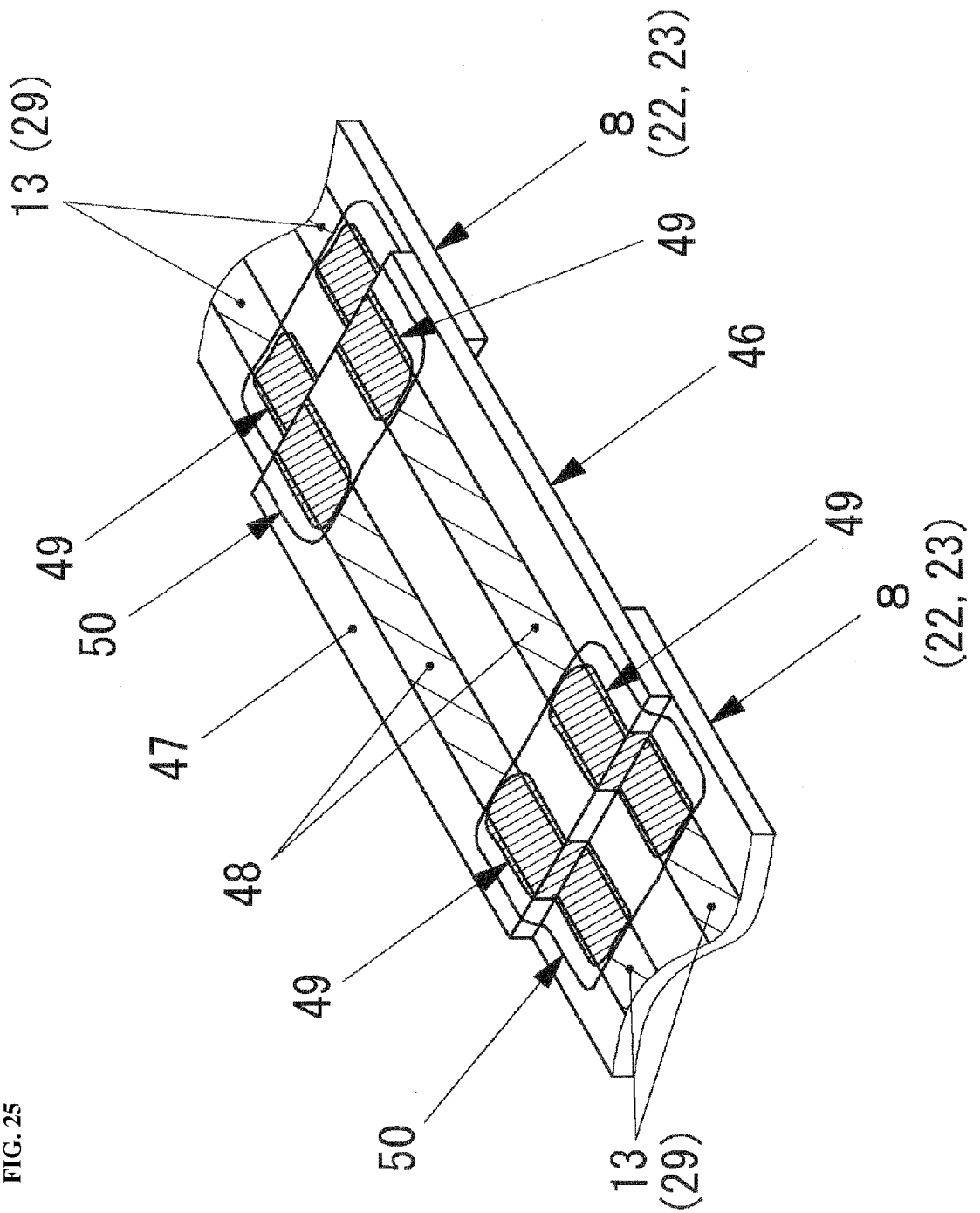


FIG. 25

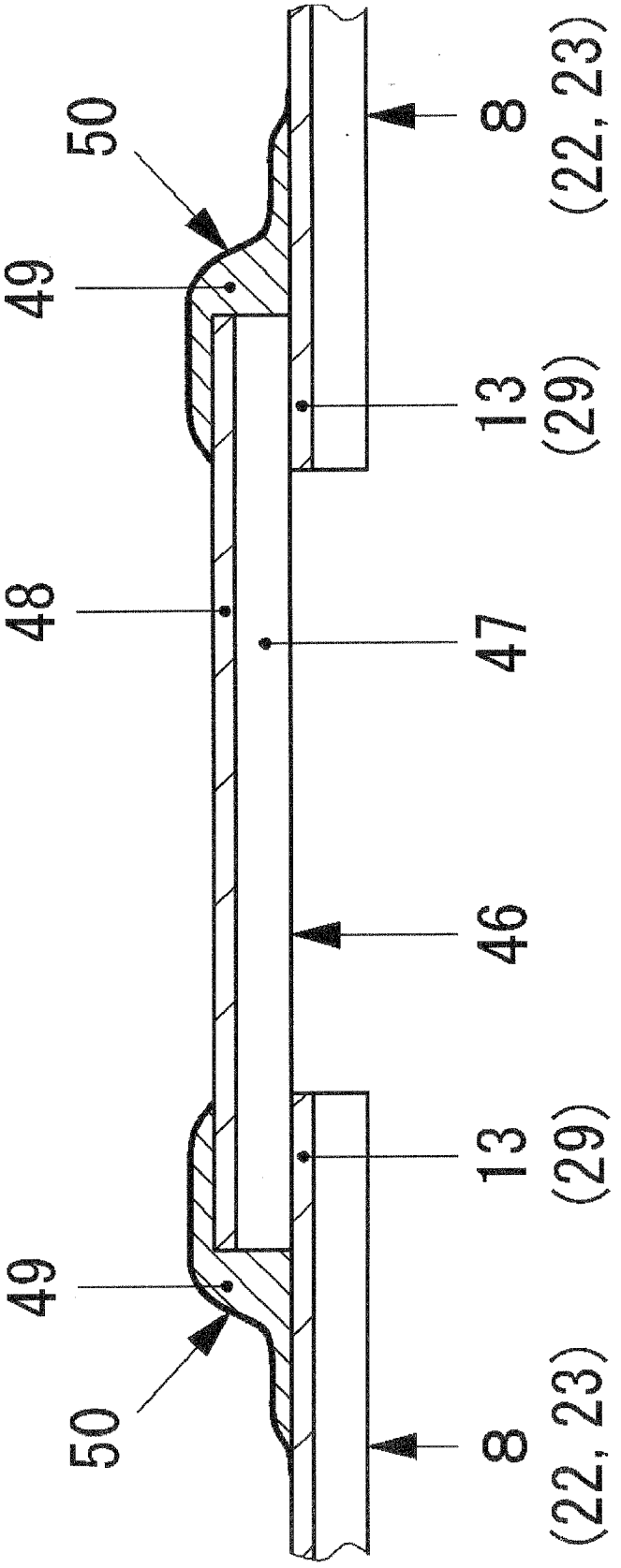


FIG. 26

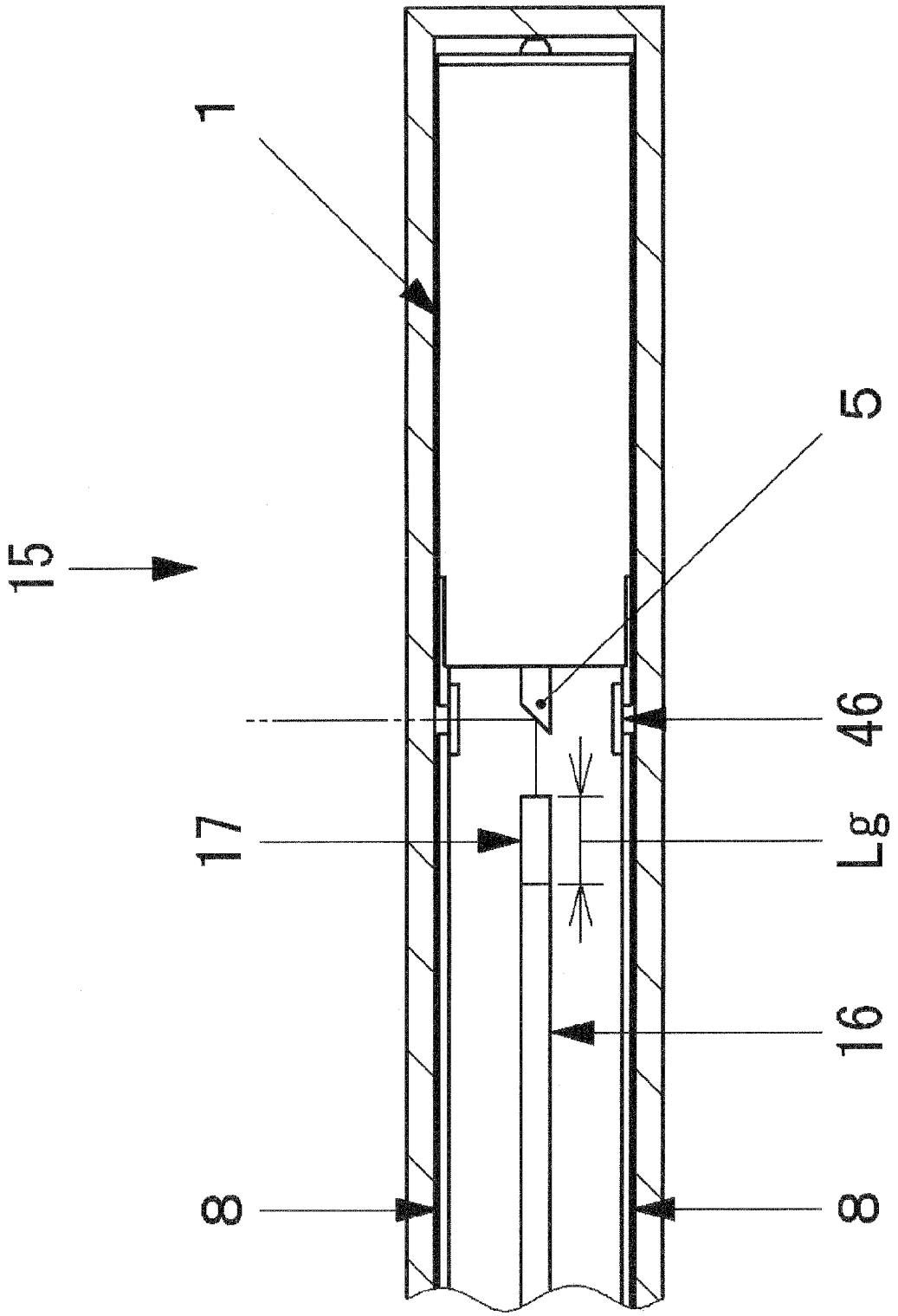


FIG. 27

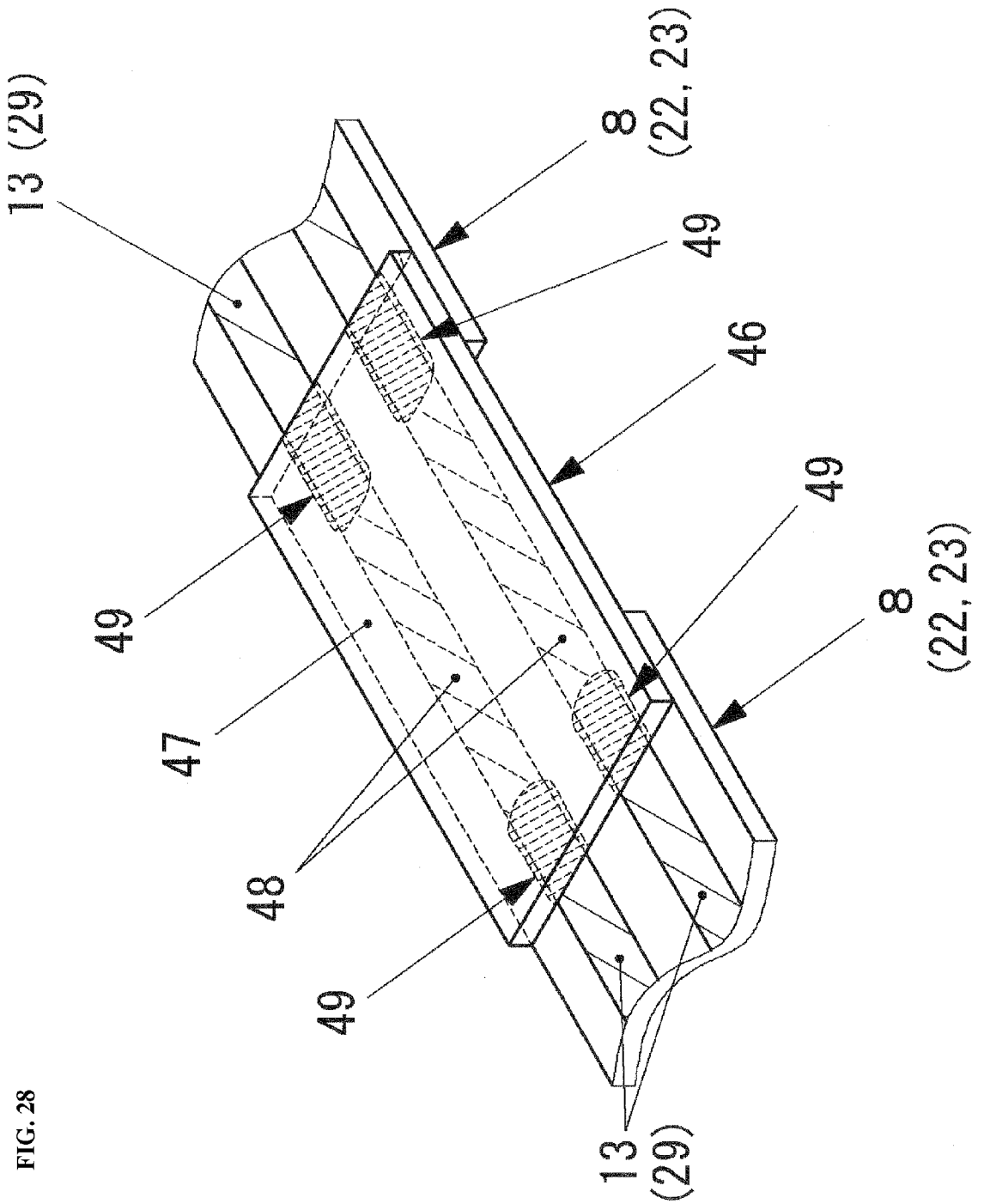


FIG. 28

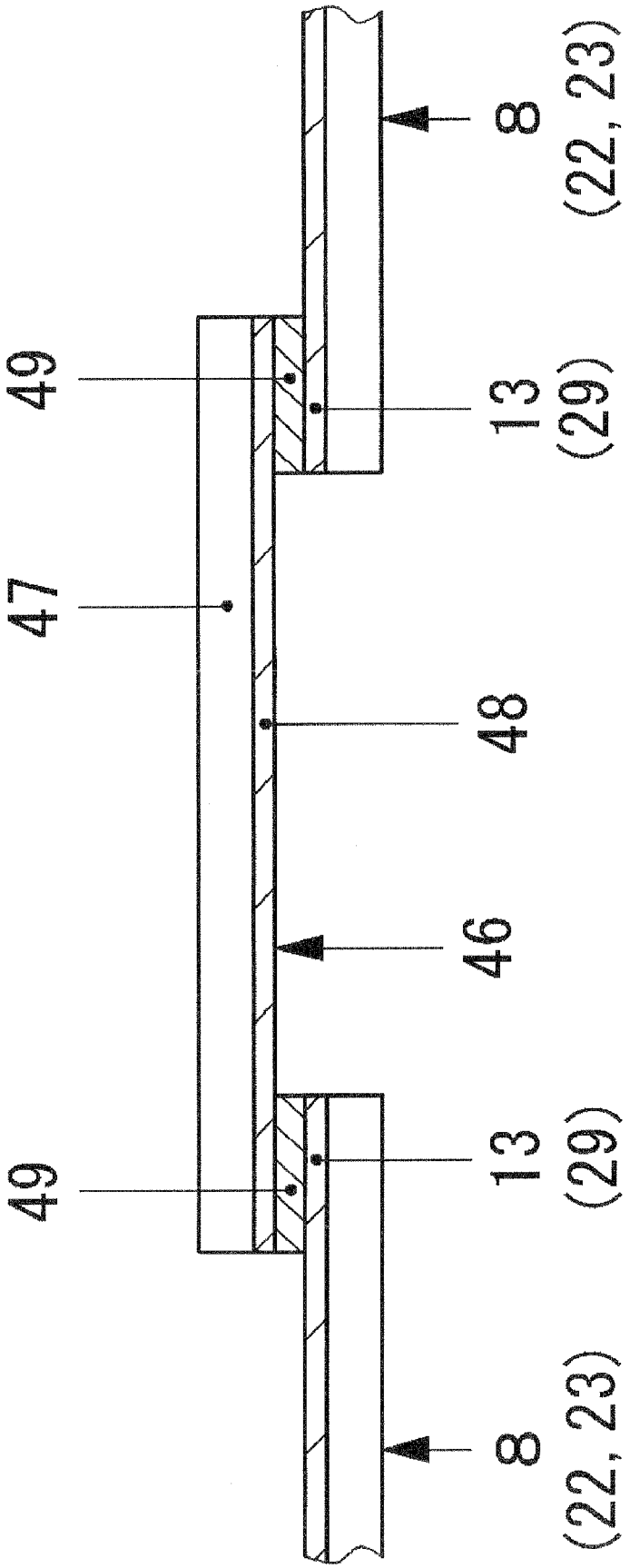


FIG. 29

FIG. 30

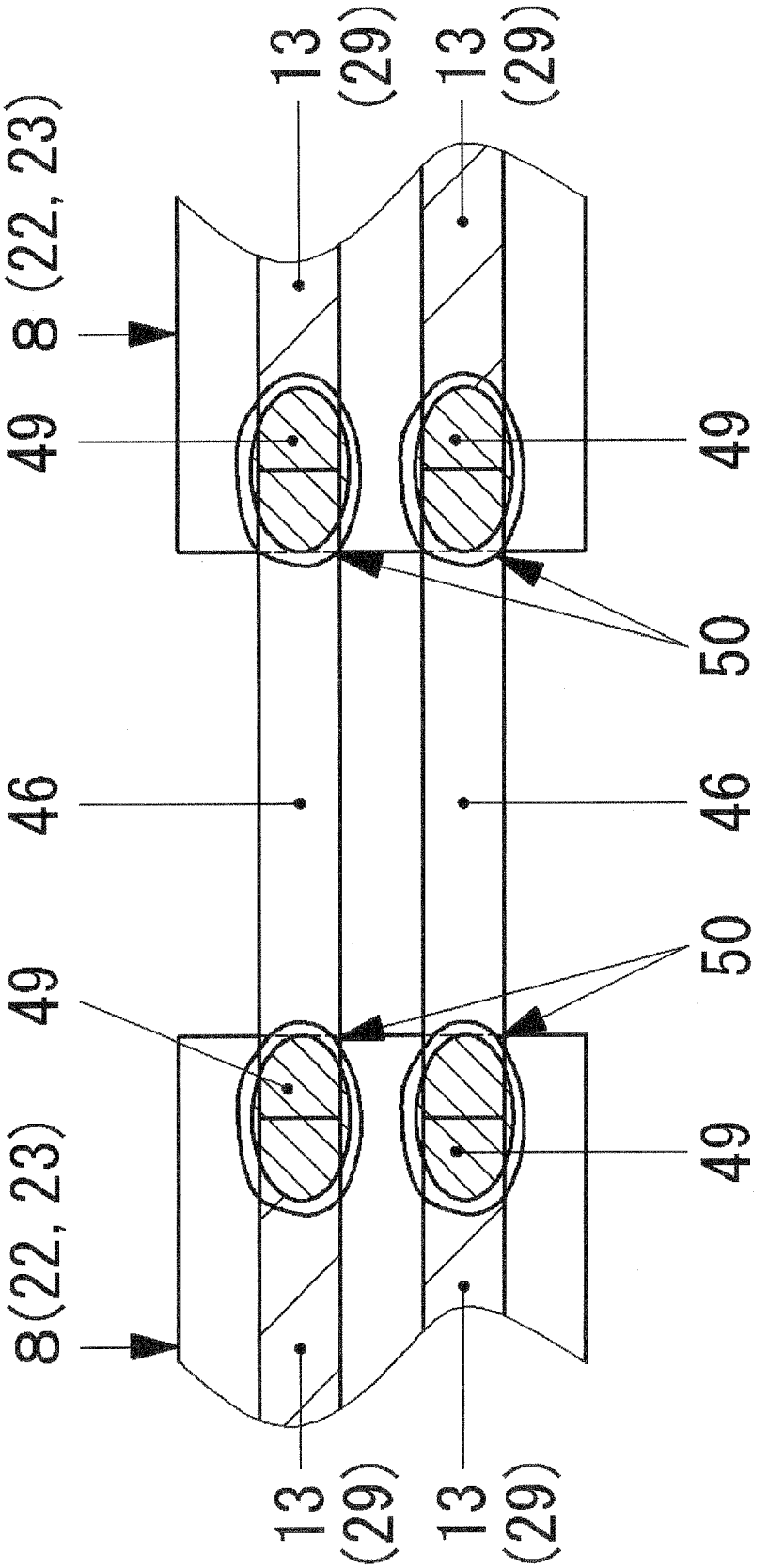
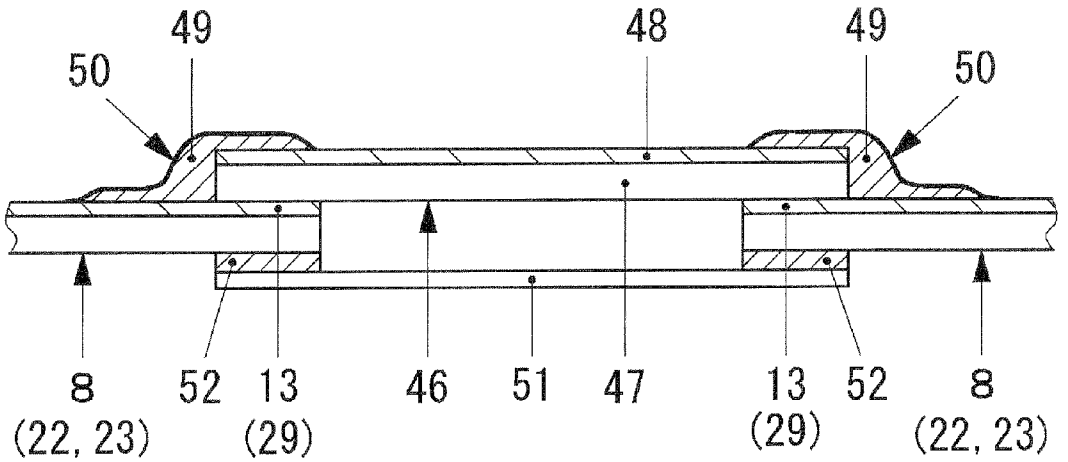
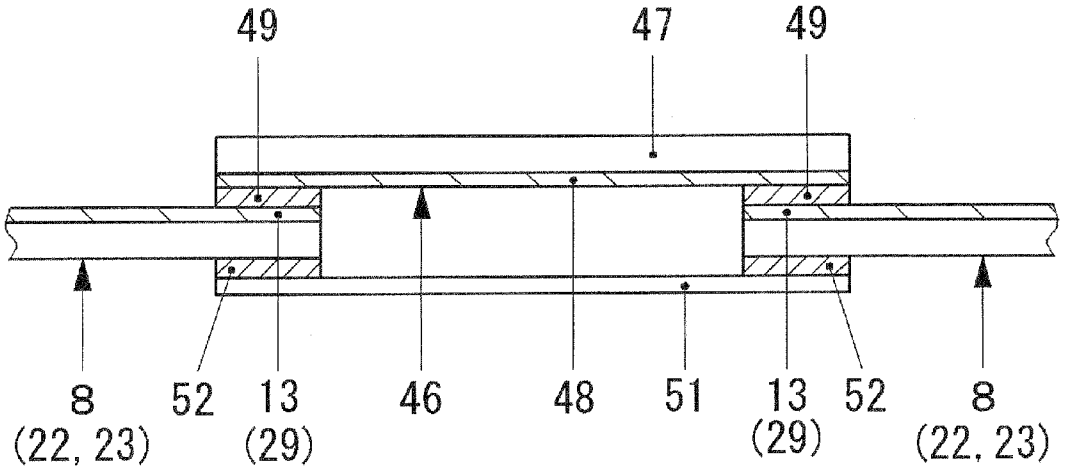


FIG. 31


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(a)


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(b)

MOTOR AND ENDOSCOPE PROBE EQUIPPED WITH MOTOR

TECHNICAL FIELD

[0001] The present invention relates to a motor used in an endoscope probe and an endoscope probe equipped with the motor.

RELATED ART

[0002] Recently, as the use of an image in diagnosis has spread, importance of a technique for measuring internal information of a subject in a non-invasive or non-contact manner has been gradually increased.

[0003] Conventionally, the non-invasive or non-contact measurement of the internal information of the subject such as an organism was mainly performed by X-rays. However, if the X-rays are used, a problem such as exposure to radiation occurs or imaging of a biometric function is hard to be achieved. Accordingly, observation of a tissue inside a body cavity by an ultrasonic endoscope probe has been performed.

[0004] However, since the ultrasonic endoscope probe has low spatial resolution, information such as physiologic compositions other than a shape cannot be obtained. In addition, when the ultrasonic endoscope probe is used, since a medium such as water is required, a process of observing the subject is troublesome.

[0005] Accordingly, recently, a variety of techniques related to Optical Coherence Tomography (OCT) of making internal information of a subject visible using light has been suggested. For example, the related art is disclosed in Patent Document 1. An OCT endoscope probe is inserted into a body cavity organ and OCT scanning is then performed, such that tomogram of an organ wall is acquired.

[0006] Patent Document 1: US2005/0143664

[0007] In order to perform the scanning of the light necessary for observing the tomogram by a simple operation with certainty, in Patent Document 1, as shown in FIG. **22**, an OCT endoscope probe **100** (hereinafter, referred to as a probe **100** if necessary) in which a motor **101** with a small diameter is placed on a probe front end **102** is formed. In addition, an optical fiber **103** faces a shaft **104** of the motor **101**, and a prism or mirror is fixed to the end of the shaft **104** as a scanner **105** for reflecting light emitted from the optical fiber **103** at an inclination angle of 45 degrees (in FIG. **22**, an embodiment of the prism is shown). In Patent Document 1, by reflecting the light emitted from the optical fiber **103** at the surface of the scanner **105** at 90 degrees and rotating the shaft **104**, an optical path is changed by an angle of 90 degrees to an optical axis direction of the optical fiber **103** so as to perform OCT scanning of the inside of a subject.

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

[0008] However, in the configuration of the OCT endoscope probe **100** shown in FIG. **22**, since the motor **101** is mounted in the OCT endoscope probe **100** such that the end of the shaft **104** faces the end of the optical fiber **103**, an electric power supply portion of the motor **101** is placed on the side of the front end **102** of the body of the OCT endoscope probe **100**.

[0009] Accordingly, in order to supply electric power to the motor **101**, an electric power supply wire led out from the electric power supply portion in the probe **100** is routed in the direction opposite to the side of the front end **102** and is electrically connected to a power supply for the motor **101** (not shown) placed on the side of the other end of the probe **100**. However, in order to route the electric power supply wire in the probe **100**, as schematically shown in FIG. **23**, the electric power supply wire **106** is led out in the diameter direction of the motor **101** once and the electric power supply wire **106** needs to be bent.

[0010] Accordingly, the electric power supply wire **106** is disconnected at a bent portion or R (corner R) is generated in the electric power supply wire **106** at the bent portion due to bending. The diameter of the probe **100** is increased by amount of the corner R and the length of an inflexible portion of the front end **102** of the probe is increased.

[0011] Accordingly, it is an object of the present invention for a motor which can be mounted in an endoscope probe without bending an electric power supply wire and an endoscope probe using the motor.

Means for Solving the Problems

[0012] A motor described in claim **1** of the present invention includes a magnet, a field coil, a housing, an electric power supply wire, and a shaft, a lead wire led out from the field coil is connected to the electric power supply wire, a cutout is formed in an end of the housing, and the electric power supply wire connected with the lead wire is received along the cutout and led out to the outside of the motor in the direction in which the shaft projects.

[0013] A motor described in claim **2** includes a magnet, a field coil, a housing, a flange, an electric power supply wire, and a shaft, a lead wire led out from the field coil is connected to the electric power supply wire, a cutout is formed in an end of the housing, and the electric power supply wire connected with the lead wire is received along the cutout, a flat portion is formed on an outer circumferential surface of the flange, and the electric power supply wire is placed on the flat portion, and the flange on which the electric power supply wire is placed is fixed to an end of the housing, and the electric power supply wire is led out to the outside of the motor in the direction in which the shaft projects.

[0014] The motor described in claim **3** is the motor according to claim **1** in which flanges are respectively fixed to one end and the other end of the housing, and one or both of the flanges functions as a shaft bearing.

[0015] The motor described in claim **4** is the motor according to claim **2** in which another flange is fixed to an end other than the end of the housing, to which the flange is fixed, and one or both of the flanges functions as a shaft bearing.

[0016] The motor described in claim **5** is the motor according to claim **2** in which the electric power supply wire is led out from one side of the outer circumference of the motor.

[0017] The motor described in claim **6** is the motor according to claim **1** in which at least a portion of the electric power supply wire is formed of a transparent electrode material.

[0018] The motor described in claim **7** is the motor according to claim **2** in which at least a portion of the electric power supply wire is formed of a transparent electrode material.

[0019] The motor described in claim **8** is the motor according to claim **1** in which the end of the shaft is obliquely formed to the axial direction of the shaft, and a reflective film is formed on an obliquely formed surface of the shaft such that a light reflection surface is formed in the obliquely formed surface.

[0020] The motor described in claim **9** is the motor according to claim **2** in which the end of the shaft is obliquely formed to the axial direction of the shaft, and a reflective film is formed on an obliquely formed surface of the shaft such that a light reflection surface is formed in the obliquely formed surface.

[0021] The motor described in claim **10** is the motor according to claim **1** in which the end of the shaft is obliquely formed to the axial direction of the shaft, and an obliquely formed surface of the shaft is mirror-polished such that a light reflection surface is formed in the obliquely formed surface.

[0022] The motor described in claim **11** is the motor according to claim **2** in which the end of the shaft is obliquely formed to the axial direction of the shaft, and an obliquely formed surface of the shaft is mirror-polished such that a light reflection surface is formed in the obliquely formed surface.

[0023] The motor described in claim **12** is the motor according to claim **1** in which the end of the shaft is obliquely formed to the axial direction of the shaft, and an obliquely formed surface of the shaft is mirror-polished and a reflective film is formed on the obliquely formed surface such that a light reflection surface is formed in the obliquely formed surface.

[0024] The motor described in claim **13** is the motor according to claim **2** in which the end of the shaft is obliquely formed to the axial direction of the shaft, and an obliquely formed surface of the shaft is mirror-polished and a reflective film is formed on the obliquely formed surface such that a light reflection surface is formed in the obliquely formed surface.

[0025] The motor described in claim **14** is the motor according to claim **1** in which the overall shaft is formed of amorphous metal alloy, the end of the shaft is obliquely formed to the axial direction of the shaft such that a light reflection surface is formed in an obliquely formed surface of the shaft, and the surface roughness Ry of the reflection surface is set to 0.4 μm or less.

[0026] The motor described in claim **15** is the motor according to claim **2** in which the overall shaft is formed of amorphous metal alloy, the end of the shaft is obliquely formed to the axial direction of the shaft such that a light reflection surface is formed in an obliquely formed surface of the shaft, and the surface roughness Ry of the reflection surface is set to 0.4 μm or less.

[0027] The motor described in claim **16** is the motor according to claim **1** in which the overall shaft is formed of amorphous metal alloy, the end of the shaft is obliquely formed to the axial direction of the shaft, the surface roughness Ry of an obliquely formed surface of the shaft is set to 0.4 μm or less, and a reflective film is formed on the obliquely formed surface of the shaft such that a light reflection surface is formed in the obliquely formed surface.

[0028] The motor described in claim **17** is the motor according to claim **2** in which the overall shaft is formed of amorphous metal alloy, the end of the shaft is obliquely formed to the axial direction of the shaft, the surface roughness Ry of an obliquely formed surface of the shaft is set to 0.4 μm or less, a reflective film is formed on the obliquely formed surface of the shaft such that a light reflection surface is formed in the obliquely formed surface.

[0029] A motor described in claim **18** includes a magnet, a field coil, a housing, an electric power supply wire, and a shaft, a lead wire led out from the field coil is connected to the electric power supply wire, a cutout is formed in an end of the housing, the electric power supply wire connected with the lead wire is received along the cutout, the motor further includes a reduction gear head, a pinion is formed on an end of the shaft, and the gear head is driven by and connected to the motor via the pinion, and the electric power supply wire is led out to the outside of the motor in the direction in which the shaft projects.

[0030] A motor described in claim **19** a magnet, a field coil, a housing, a flange, an electric power supply wire, and a shaft, a lead wire led out from the field coil is connected to the electric power supply wire, a cutout is formed in an end of the housing, the electric power supply wire connected with the lead wire is received along the cutout, a flat portion is formed on an outer circumferential surface of the flange, and the electric power supply wire is placed on the flat portion, the flange on which the electric power supply wire is placed is fixed to an end of the housing, the motor further includes a reduction gear head, a pinion is formed on an end of the shaft, and the gear head is driven by and connected to the motor via the pinion, and the electric power supply wire is led out to the outside of the motor in the direction in which the shaft projects.

[0031] The motor described in claim **20** is the motor according to claim **18** in which the outer diameter of the gear head is less than that of the motor.

[0032] The motor described in claim **21** is the motor according to claim **19** in which the outer diameter of the gear head is less than that of the motor.

[0033] The motor described in claim **22** is the motor according to claim **18** in which a groove for receiving the electric power supply wire is formed in the housing of the gear head, and the electric power supply wire is received in the groove, and the electric power supply wire is led out to the outside of the motor in the direction in which an output shaft of the gear head projects.

[0034] The motor described in claim **23** is the motor according to claim **19** in which a groove for receiving the electric power supply wire is formed in the housing of the gear head, and the electric power supply wire is received in the groove, and the electric power supply wire is led out to the outside of the motor in the direction in which an output shaft of the gear head projects.

[0035] The motor described in claim **24** is the motor according to claim **18** in which the end of the output shaft is obliquely formed to the axial direction of the output shaft, and a reflective film is formed on an obliquely formed surface of the output shaft such that a light reflection surface is formed in the obliquely formed surface.

[0036] The motor described in claim **25** is the motor according to claim **19** in which the end of the output shaft is obliquely formed to the axial direction of the output shaft, and a reflective film is formed on an obliquely formed surface of the output shaft such that a light reflection surface is formed in the obliquely formed surface.

[0037] The motor described in claim **26** is the motor according to claim **18** in which the end of the output shaft is obliquely formed to the axial direction of the output shaft, and an obliquely formed surface of the output shaft is mirror-polished such that a light reflection surface is formed in the obliquely formed surface.

[0038] The motor described in claim **27** is the motor according to claim **19** in which the end of the output shaft is obliquely formed to the axial direction of the output shaft, and

an obliquely formed surface of the output shaft is mirror-polished such that a light reflection surface is formed in the obliquely formed surface.

[0039] The motor described in claim **28** is the motor according to claim **18** in which the end of the output shaft is obliquely formed to the axial direction of the output shaft, and an obliquely formed surface of the output shaft is mirror-polished and a reflective film is formed on the obliquely formed surface such that a light reflection surface is formed in the obliquely formed surface.

[0040] The motor described in claim **29** is the motor according to claim **19** in which the end of the output shaft is obliquely formed to the axial direction of the output shaft, and an obliquely formed surface of the output shaft is mirror-polished and a reflective film is formed on the obliquely formed surface such that a light reflection surface is formed in the obliquely formed surface.

[0041] The motor described in claim **30** is the motor according to claim **18** in which the overall output shaft is formed of amorphous metal alloy, the end of the output shaft is obliquely formed to the axial direction of the output shaft such that a light reflection surface is formed in an obliquely formed surface of the output shaft, and the surface roughness Ry of the reflection surface is set to 0.4 μm or less.

[0042] The motor described in claim **31** is the motor according to claim **19** in which the overall output shaft is formed of amorphous metal alloy, the end of the output shaft is obliquely formed to the axial direction of the output shaft such that a light reflection surface is formed in an obliquely formed surface of the output shaft, and the surface roughness Ry of the reflection surface is set to 0.4 μm or less.

[0043] The motor described in claim **32** is the motor according to claim **18** in which the overall output shaft is formed of amorphous metal alloy, the end of the output shaft is obliquely formed to the axial direction of the output shaft, the surface roughness Ry of an obliquely formed surface of the output shaft is set to 0.4 μm or less, and a reflective film is formed on the obliquely formed surface of the output shaft such that a light reflection surface is formed in the obliquely formed surface.

[0044] The motor described in claim **33** is the motor according to claim **19** in which the overall output shaft is formed of amorphous metal alloy, the end of the output shaft is obliquely formed to the axial direction of the output shaft, the surface roughness Ry of an obliquely formed surface of the output shaft is set to 0.4 μm or less, a reflective film is formed on the obliquely formed surface of the output shaft such that a light reflection surface is formed in the obliquely formed surface.

[0045] An endoscope probe described in claim **34** includes the motor according to any one of claims **1** to **33**, the motor is placed in the endoscope probe body such that the shaft or the output shaft projects in the direction opposite to the direction of the front end of the endoscope probe, and the electric power supply wire led out to the outside of the motor is routed along the longitudinal direction of the endoscope probe.

EFFECT OF THE INVENTION

[0046] According to claims **1**, **2**, **18**, **19** and **34** of the present invention, since the electric power supply wire is led out in the direction in which the shaft of the motor projects or the direction in which the output shaft of the gear head projects, when the motor is mounted in the endoscope probe and the electric power supply wire is routed in the endoscope probe body, the electric power supply wire may not be bent. Accordingly, it is possible to prevent disconnection of the electric power supply wire and solve generation of R (corner R) of a bent portion generated due to bending. Therefore, it is possible to suppress the increase in diameter of the endoscope probe and to shorten an inflexible portion of the front end of the endoscope probe.

[0047] According to the motor described in claim **1**, since the electric power supply wire is received in the cutout and led out to the outside of the motor, it is possible to prevent protrusion of the electric power supply wires in the diameter direction of the motor. Even in this case, it is possible to suppress the increase in diameter of the endoscope probe.

[0048] According to the motor described in claim **2**, since the flat portion is formed on the outer circumferential surface of the flange and the electric power supply wire is placed on the flat portion, it is possible to prevent protrusion of the electric power supply wires in the diameter direction of the motor. Therefore, it is possible to suppress the increase in diameter of the probe.

[0049] According to the motor described in claim **3** or **4**, since the flange functions as the shaft bearing, the number of parts included in the diameter direction of the motor can be reduced and thus the motor and the endoscope probe can be further downsized.

[0050] According to the motor described in claim **5**, since the electric power supply wire is led out from only the circumference of one side of the motor to the outside of the motor, the number of electric power supply wires which become an obstacle at the time of scanning of the probe can be reduced and thus the rotation angle of the scanning shaft or output shaft is enlarged.

[0051] According to the motor described in claim **6** or **7**, when the endoscope probe is scanned at a rotation angle of 360 degrees, it is possible to prevent the electric power supply wire of the motor from becoming an obstacle to scanning.

[0052] According to the motor described in claim **20** or **21**, the electric power supply wire led out from the motor does not protrude in the outer diameter direction of the motor in the outer circumference of the gear head and the electric power supply wire can be led out to the outside of the motor in the direction in which the output shaft of the gear head projects. Therefore, it is possible to suppress the increase in diameter of the endoscope probe.

[0053] According to the motor described in claim **22** or **23**, since the groove for receiving the electric power supply wire is formed in the housing of the gear head, the electric power supply wire is received in the groove, and the electric power supply wire is led out to the outside of the motor in the direction in which the output shaft of the gear head projects, it is possible to prevent protrusion of the electric power supply wire to the outer circumference of the gear head even when the outer diameter of the gear head is set to at least the outer diameter of the motor. Therefore, it is possible to suppress the increase in diameter of the endoscope probe.

[0054] According to the motor described in any one of claims **8** to **17** or **24** to **33**, since the end of the shaft or the end of the output shaft of the motor is formed of the light reflection surface, an optical part for a scanner, such as a mirror or a prism, is unnecessary in the end of the shaft or the end of the output shaft. Accordingly, a space occupied by the scanner in the internal space of the front end of the probe can be elimi-

nated and the inflexible portion of the front end of the OCT endoscope probe can be shortened. In addition, the number of parts can be reduced.

[0055] Since the light reflection surface is directly formed in the end of the shaft or the end of the output shaft, further, the optical path of the light after being reflected from the reflection surface can be set by desire and efficient light transmission to the subject can be achieved.

[0056] In addition, since a separate part such as the optical part for the scanner is not attached to the shaft or the output shaft, it is possible to rotate the shaft or the output shaft with low torque and suppress the increase in size of the motor. Accordingly, it is possible to suppress the increase in diameter of the overall OCT endoscope probe.

[0057] By removing the optical part for the scanner, it is possible to reduce one axial shift element between the core axis of the optical fiber and axis of the motor.

[0058] According to the motor described in claim **8**, **9**, **24**, **25**, **10**, **11**, **26** or **27**, by forming the reflective film on the end of the shaft or the end of the output shaft or performing mirror polishing, the light reflection efficiency of the end of the shaft or the end of the output shaft is improved and thus light propagation efficiency is also improved.

[0059] According to the motor described in claim **14**, **15**, **30** or **31**, since the overall shaft or output shaft is formed of amorphous metal alloy, due to the characteristics of the amorphous metal alloy without a crystal grain boundary, it is possible to improve surface smoothness of the reflection surface. Accordingly, since the amorphous metal alloy has a good mold transfer property in the injection molding process or a good polishing property in the polishing process, surface smoothness is excellent. As a result, the reflection efficiency of the manufactured reflection surface is also improved and the light propagation efficiency is also improved.

[0060] According to the motor described in claim **12**, **13**, **16**, **17**, **28**, **29**, **32** or **33**, the obliquely formed surface on which the reflective film is formed is mirror-formed and the reflective film is then formed. Accordingly, it is possible to further improve the reflection efficiency of the reflection surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0061] FIG. **1** is a cross-sectional view of a motor according to a first embodiment of the present invention.

[0062] FIG. **2** is an exploded perspective view showing the structure of a stator of the motor of FIG. **1**.

[0063] FIG. **3** is a side view of the motor of FIG. **1**.

[0064] FIG. **4** is a schematic view of the internal structure of an OCT endoscope probe in which the motor of FIG. **1** is mounted.

[0065] FIG. **5**A is a partial enlarged view of an end of a shaft of the motor of FIG. **1** and is a partial enlarged view showing the end of the shaft in which a reflective film is formed on an obliquely formed surface.

[0066] FIG. **5**B is a partial enlarged view of the end of the shaft of the motor of FIG. **1** and is a partial enlarged view showing the end of the shaft in which the obliquely formed surface is subjected to mirror polishing.

[0067] FIG. **6** is a cross-sectional view of a motor according to a second embodiment of the present invention.

[0068] FIG. **7** is an exploded perspective view showing the structure of a stator of the motor of FIG. **6**.

[0069] FIG. **8** is a schematic view of the internal structure of an OCT endoscope probe in which the motor of FIG. **6** is mounted.

[0070] FIG. **9** is a cross-sectional view of a motor according to a third embodiment of the present invention.

[0071] FIG. **10** is an exploded perspective view showing the structure of a stator of the motor of FIG. **9**.

[0072] FIG. **11** is a schematic view of the internal structure of an OCT endoscope probe in which the motor of FIG. **9** is mounted.

[0073] FIG. **12** is a cross-sectional view of a geared motor according to a fourth embodiment.

[0074] FIG. **13** is a cross-sectional view taken along line A-A of FIG. **12**.

[0075] FIG. **14** is a shaft perspective view showing a pinion formed on an end of a shaft of the motor of FIG. **12**.

[0076] FIG. **15** is a side view of the geared motor of FIG. **12**.

[0077] FIG. **16** is a schematic view of the internal structure of an OCT endoscope probe in which the geared motor of FIG. **12** is mounted.

[0078] FIG. **17** is a cross-sectional view of a geared motor according to another example of the fourth embodiment.

[0079] FIG. **18** is a cross-sectional view taken along line B-B of FIG. **17**.

[0080] FIG. **19** is a perspective view showing the geared motor of FIG. **17**.

[0081] FIG. **20**A is a partial enlarged view of an end of an output shaft of the geared motor of FIG. **12** and is a partial enlarged view showing the end of the output shaft in which a reflective film is formed on an obliquely formed surface.

[0082] FIG. **20**B is a partial enlarged view of the end of the output shaft of the geared motor of FIG. **12** and is a partial enlarged view showing the end of the output shaft in which the obliquely formed surface is subjected to mirror polishing.

[0083] FIG. **21** is a partial enlarged perspective view showing another shape of an electric power supply wire of the motor shown in FIG. **6** or FIG. **9**.

[0084] FIG. **22** is a schematic view of the internal structure of a conventional OCT endoscope probe in which a motor is mounted.

[0085] FIG. **23** is a schematic view of the internal structure of a front end of the probe of FIG. **22**.

[0086] FIG. **24** is a perspective view of a motor according to the present invention in which a portion of the electric power supply wire is formed of a transparent electrode material.

[0087] FIG. **25** is an enlarged perspective view of an electric power supply wire portion C of FIG. **24**.

[0088] FIG. **26** is a side view schematically showing FIG. **25**.

[0089] FIG. **27** is a schematic view of the internal structure of an OCT endoscope probe in which the motor of FIG. **24** is mounted.

[0090] FIG. **28** is an enlarged perspective view showing a modified example of FIG. **25**.

[0091] FIG. **29** is a side view schematically showing FIG. **28**.

[0092] FIG. **30** is a partial plan view showing another modified example of FIG. **25**.

[0093] FIG. **31**A is a side view showing a structure in which a reinforcing material is used in the electric power supply wire portion of FIG. **26**.

[0094] FIG. **31**B is a side view showing a structure in which a reinforcing material is used in the electric power supply wire portion of FIG. **29**.

REFERENCE NUMERALS

[0095] **1**, **18**, **44**: motor
[0096] **2**: magnet
[0097] **3**: field coil
[0098] **4**, **19**, **45**: (motor) housing
[0099] **5**: shaft
[0100] **6**, **20**: lead wire guide
[0101] **7**, **21**, **28**: flange
[0102] **8**, **22**, **23**, **22***a*: flexible substrate
[0103] **9**: tap wire
[0104] **10**: groove
[0105] **11**: shaft bearing
[0106] **12**: twisted wire
[0107] **13**, **29**: electric power supply land
[0108] **14**: reflective film
[0109] **15**: OCT endoscope probe
[0110] **16**: single-mode optical fiber
[0111] **17**: graded-index optical fiber
[0112] **24**: cutout
[0113] **25**: step
[0114] **26**, **27**: flat portion
[0115] **30**: geared motor
[0116] **31**: gear head
[0117] **32**: pinion
[0118] **33**: (gear head) housing
[0119] **34**: reduction gear mechanism
[0120] **35**: output shaft
[0121] **36***a*, **36***b*, **36***c*: carrier unit
[0122] **37**, **37***c*: shaft portion
[0123] **38**: sun gear
[0124] **39**, **39***c*: carrier
[0125] **40**, **40***c*: planetary gear
[0126] **41**: internal gear
[0127] **42**: electric power supply wire receiving groove
[0128] **43**: lead wire
[0129] **46**: transparent electrode material
[0130] **47**: PET or glass substrate
[0131] **48**: ITO- or ZnO-based material
[0132] **49**: conductive adhesive or the like
[0133] **50**: protective film
[0134] **51**: reinforcing material
[0135] **52**: adhesive, adhesion tape or the like

BEST MODE FOR CARRYING OUT THE INVENTION

First Embodiment

[0136] Hereinafter, a first embodiment of a motor and an endoscope probe according to the present invention will be described in detail with reference to FIGS. **1** to **5**. FIG. **1** is a cross-sectional view of the motor according to the first embodiment. FIG. **2** is an exploded perspective view showing the structure of a stator of the motor of FIG. **1**. FIG. **3** is a side view of the motor of FIG. **1**. FIG. **4** is a schematic view of the internal structure of the endoscope in which the motor of FIG. **1** is mounted and, more particularly, an OCT endoscope probe. FIGS. **5**A and **5**B are partial enlarged views of an end of a shaft of the motor of FIG. **1**.

[0137] In FIG. **1**, the motor **1** includes a magnet **2**, a field coil **3**, a housing **4**, flexible substrates **8** functioning as electric power supply wires, a shaft **5**. In FIG. **2**, the stator of the motor **1** includes the housing **4**, the field coil **3**, a lead wire guide **6**, a flange **7** and the flexible substrates **8**.

[0138] The appearance of the housing **4** has a substantially cylindrical shape and cutouts **24** and **24** are formed in an end thereof. Six lead wires are lead out from the field coil **3**, and a total of three tap wires **9** and twisted wires **12** which are neutral points are formed one by one. Four grooves **10** are included in the lead wire guide **6**. The flange **7** includes shaft bearings **11** (see FIG. **1**).

[0139] Meanwhile, as shown in FIG. **1**, the field coil **3** is placed on and fixed to an inner wall of the housing **4**, and the lead wire guide **6** is placed on the side of the tap wires **9** and the twisted wires **12** of the field coil **3**. A rotor including the magnet **2** and the shaft **5** penetrating through the center thereof is inserted into the field coil **3** so as to face the inside of the field coil **3** with a gap interposed therebetween and is rotatably held by the shaft bearings **11** and **11**. Accordingly, the magnet **2** and the shaft **5** are placed in the housing **4**.

[0140] The tap wires **9** and the twisted wires **12** formed by leading out from the field coil **3** are extended in the grooves **10** of the lead wire guide **6** and connected to the flexible substrates **8** and **8**. At this time, by adhering electric power supply lands **13** of the flexible substrates **8** and **8**, portions in which the tap wires **9** and the twisted wires **12** are connected by a solder and the grooves **10** with an adhesive or the like, a structure, in which disconnection is prevented without exerting overload on the tap wires **9**, the twisted wires **12** and connection portions, is obtained, and fixing strength is increased. The field coil **3**, the lead wire guide **6** and the flexible substrate **8** and **8** are received in the housing **4**, and the flange **7** is inserted into and fixed to the end side of the housing **4** in which the cutouts **24** and **24** are formed. Since the flange **7** is inserted into the end side of the housing **4**, the outer diameter of the flange **7** is equal to or less than that of the housing **4**. By the above-described configuration, a DC brushless motor **1** is formed and the overall outer diameter D of the motor **1** (see FIG. **3**) may be set to about 2 mm which is equal to or less than 3 mm.

[0141] The flexible substrates **8** and **8**, to which the lead wires (the tap wires **9** and twisted wires **12**) are connected, are bent at a right angle and received along the cutouts **24** and **24** so as to be led out to the outside of the motor **1** without protruding from the outer diameter of the motor **1**. The direction in which the flexible substrates **8** and **8** are led out is equal to the direction in which the shaft **5** projects.

[0142] In the motor **1** according to the present invention, as shown in FIGS. **3** and **5**, the end of the shaft **5** is obliquely cut to the axial direction of the shaft **5** such that the end of the shaft **5** is obliquely formed in the axial direction of the shaft **5**. The cut angle θ may be set to a desired angle according to the requirement characteristics of the endoscope probe in which the motor **1** is mounted. In the present embodiment, the cut angle is, for example, 45 degrees. In addition, stainless steel is generally used in the shaft **5**.

[0143] In an obliquely formed surface **5***a* of the shaft **5**, a reflective film **14** is formed (see FIG. **5**A) or mirror polishing is performed (see FIG. **5**B) such that a light reflection surface is formed. If the mirror polishing is performed, the obliquely formed surface **5***a* is mechanically polished so as to perform mirror finishing. In addition, if the reflective film **14** is formed, a metallic film or a dielectric multi-layer film with high reflectivity, such as aluminum, nickel, gold or silver, is

formed on the obliquely formed surface **5***a*. As the film forming method, deposition, sputtering, CVD, plating, coating or the like may be used.

[0144] Alternatively, the overall shaft **5** may be formed of amorphous metal alloy. By such a configuration, the reflection surface is formed of the amorphous metal alloy, but the surface roughness Ry of the reflection surface is set to 0.4 μm or less and more preferably 0.1 μm or less. By setting the surface roughness Ry to the above range, it is possible to prevent light reflection efficiency of the reflection surface from deteriorating.

[0145] As the amorphous metal alloy, amorphous metal alloy having at least one of elements such as Fe, Ni, Cu, Ti and Zr as main components is preferably used.

[0146] If the overall shaft **5** is formed of amorphous metal alloy, the overall shaft **5** is manufactured by injection molding. In particular, it is preferable that polishing is performed to a mold for molding the reflection surface and the mold surface roughness Ry is set to 0.4 μm or less and, more particularly, 0.1 μm or less, because the light reflection efficiency of the reflection surface after transferring is prevented from deteriorating as described above.

[0147] Alternatively, the light reflection surface may be formed in the obliquely formed surface **5***a* by combining the technical elements, for example, mirror-polishing the obliquely formed surface **5***a* of the shaft **5** and forming the reflective film **14** on the obliquely formed surface **5***a*. In addition, the light reflection surface may be formed in the obliquely formed surface **5***a* by forming the overall shaft **5** using amorphous metal alloy, setting the surface roughness Ry of the obliquely formed surface **5***a* of the shaft **5** to 0.4 μm or less and forming the reflective film **14** on the obliquely formed surface **5***a*.

[0148] The motor **1** configured as described above is mounted in the OCT endoscope probe **15** shown in FIG. **4** (hereinafter, referred to as the probe **15** if necessary). In the OCT endoscope probe **15**, a single mode optical fiber **16** is provided as an optical propagation path, and the motor **1** is further placed on a distal portion in the body of the OCT endoscope probe **15**. When the motor **1** is placed in the body of the OCT endoscope probe **15**, the direction in which the shaft **5** projects to the outside of the motor **1** is opposite to the direction of the front end of the OCT endoscope probe **15**. By placing the motor **1** as described above, the reflection surface of the end of the shaft **5** faces the end of the optical fiber **16**.

[0149] On the end of the optical fiber **16**, in order to collimate the light emitted from the optical fiber **16** or make the light convergent so as to set a focal point, a graded-index optical fiber **17** is included. The reflection surface faces the end of the graded-index optical fiber **17** such that the light emitted from a light source (not shown) is propagated in a core of the optical fiber **16**, is emitted from the end of the graded-index optical fiber **17**, and is reflected from the reflection surface, the optical path thereof is changed by 90 degrees, and the light is irradiated to an organ, thereby forming an image. In addition, the reflection surface is rotated by driving the motor **1** so as to perform OCT scanning such that tomogram of an organ wall is acquired.

[0150] In addition, as shown in FIGS. **24** and **25**, at least a portion or whole of the two flexible substrates **8** and **8** may be changed to be formed of a transparent electrode material **46** which is optically transparent. FIG. **25** is an enlarged view of an electric power supply wire portion C formed of the transparent electrode material **46** and the flexible substrates **8** and **8** of FIG. **24**. As shown in FIGS. **25** and **26**, as the transparent electrode material **46**, an Indium Tin Oxide (ITO) **48** patterned on a Polyethylene Terephthalate (PET) surface **47** or a ZnO-based material **48** patterned on the surface of the PET **47** or a glass substrate **47** is suitably used. The electrical connection between the electric power supply lands **13** of the flexible substrates **8** and **8** and the transparent electrode (ITO- or ZnO-based material) **48** is, as shown in FIGS. **25** and **26**, performed by compression bonding or a conductive adhesive, a low melting point solder, or various pastes such as a silver paste, a copper paste or a carbon paste denoted by a reference numeral **49**, and a connection portion is covered by a protective film **50**.

[0151] The portion of the flexible substrates **8** and **8** is the electric power supply wire portion placed on the optical path of the light reflected from the reflection surface of the shaft **5** which is a portion of the motor **1**. Accordingly, at the time of scanning of the probe **15**, as shown in FIG. **27**, the portion of the transparent electrode material **46** which does not overlap with the flexible substrates **8** and **8** is placed on the optical path of the reflected light. By forming at least a portion of the electric power supply wires (flexible substrates **8**) using the transparent electrode material **46**, it is possible to prevent the electric power supply wires from becoming an obstacle at the time of 360-degree scanning of the probe **15**. As described above, the flexible substrates **8** may be replaced with a lead wire or a leaf spring type connection terminal. In addition, the electrical connection between the electric power supply lands **13** and the transparent electrode (ITO- or ZnO-based material) **48** may be performed by, as shown in FIGS. **28** and **29**, facing the electric power supply lands **13** and the transparent electrode (ITO- or ZnO-based material) **48** or by, as shown in FIG. **30**, electrically connecting only the electric power supply lands **13** and **13** of the flexible substrates **8** and **8** to the transparent electrode material **46**.

[0152] As shown in FIG. **31**A or **31**B, a high transmissivity material in a wavelength region of the light propagating in the optical fiber **16** may be used as a reinforcing material **51** of the connection portion of the transparent electrode material **46**. The fixing of the reinforcing material **51** may be performed by an adhesive, an adhesion tape or the like, which is denoted by a reference numeral **52**.

[0153] The graded-index optical fiber **17** includes a clad and a core having a gradient having a parabolic refractive distribution. The length Lg of the graded-index optical fiber is set to a length corresponding to a quarter of a zigzag period of the light propagating in the core or an odd multiple thereof, when it is used for collimation. In contrast, if the graded-index optical fiber is used for light convergence, the length thereof is set to a quarter to a half of the zigzag period of the light propagating in the core.

[0154] If the graded-index optical fiber **17** is formed, the graded-index optical fiber **17** may be fusion-spliced to one end of the optical fiber **16** and, thereafter, the graded-index optical fiber **17** may be cut with a desired core length Lg.

[0155] Alternatively, the graded-index optical fiber **17** may be replaced with a GRIN lens. If the GRIN lens is used for collimation, the length (corresponding to Lg) of the GRIN lens may be set to 0.25P (P: the pitch of the GRIN lens) or an odd multiple of 0.25P. In contrast, if the GRIN lens is used for light convergence, the length (corresponding to Lg) of the GRIN lens may be set to a range from 0.25P to 0.5P.

[0156] As described above, the flexible substrates **8** and **8** are received along the cutouts **24** and **24** so as to be led out to

the outside of the motor **1** without protruding from the outer diameter of the motor **1**. Accordingly, when the motor **1** is mounted in the body of the OCT endoscope probe **15**, the flexible substrates **8** and **8** are routed along the longitudinal direction of the OCT endoscope probe **15**. Accordingly, when the flexible substrates **8** and **8** are routed in the body of the probe **15**, the flexible substrates **8** and **8** may not be bent. Accordingly, it is possible to prevent disconnection of the flexible substrates **8** and **8** and to solve generation of R (corner R) of a bent portion generated due to bending. Therefore, it is possible to suppress the increase in diameter of the probe **15** and to shorten an inflexible portion of the front end of the probe **15**.

[0157] In addition, since the flexible substrates **8** and **8** are received in the cutouts **24** and **24** and are led out to the outside of the motor **1**, it is possible to prevent protrusion of the electric power supply wires (flexible substrates **8** and **8**) in the diameter direction of the motor **1**. Even in this case, it is possible to suppress the increase in diameter of the probe **15**.

[0158] In the electric power supply wire, instead of the flexible substrates **8** and **8**, for example, a lead wire or a leaf spring type connection terminal may be used. In addition, the connection between the lead wire of the field coil **3** and the electric power supply wires may be performed by a connection terminal, instead of direct fixing using a solder, in the present embodiment.

[0159] As described above, according to the present embodiment, since the end of the shaft **5** of the motor **1** is formed by the light reflection surface, an optical part for a scanner, such as a mirror or a prism, is unnecessary in the end of the shaft **5**. Accordingly, a space occupied by the scanner in the internal space of the front end of the probe can be eliminated and the inflexible portion of the front end of the OCT endoscope probe **15** can be shortened. In addition, the number of parts can be reduced.

[0160] Since the light reflection surface is directly formed in the end of the shaft **5**, the optical path of the light after being reflected from the reflection surface can be set by desire and efficient light transmission to the subject can be achieved.

[0161] In addition, since a separate part such as the optical part for the scanner is not attached to the shaft **5** of the motor **1**, it is possible to rotate the shaft **5** with low torque and suppress the increase in size of the motor **1**. Accordingly, it is possible to suppress the increase in diameter of the overall OCT endoscope probe **15**.

[0162] By removing the optical part for the scanner, it is possible to reduce one axial shift element between the core axis of the optical fiber **16** and axis of the motor **1**.

[0163] By forming the reflective film **14** on the end of the shaft **5** or performing mirror polishing, the light reflection efficiency of the end of the shaft **5** is improved and thus light propagation efficiency is also improved.

[0164] Since the amorphous metal alloy does not have a crystal grain boundary, it is possible to improve surface smoothness of the reflection surface by forming the overall shaft **5** using the amorphous metal alloy. Accordingly, since the amorphous metal alloy has a good mold transfer property in the injection molding process or a good polishing property in the polishing process, surface smoothness is excellent. As a result, the reflection efficiency of the manufactured reflection surface is also improved and the light propagation efficiency is also improved.

[0165] In addition, by mirror-polishing the obliquely formed surface **5***a* of the shaft **5** and forming the reflective film **14** on the obliquely formed surface **5***a* so as to form the light reflection surface on the obliquely formed surface **5***a* or by forming the overall shaft **5** using the amorphous metal alloy, setting the surface roughness Ry of the obliquely formed surface **5***a* of the shaft **5** to 0.4 μm or less and forming the reflective film **14** on the obliquely formed surface **5***a* so as to form the light reflection surface on the obliquely formed surface **5***a*, the obliquely formed surface **5***a* on which the reflective film **14** is formed is mirror-formed and the reflective film **14** is then formed. Accordingly, it is possible to further improve the reflection efficiency of the reflection surface.

[0166] The probe **15** may be an ultrasonic probe or other probe, instead of the OCT probe. When the motor **1** is placed in the ultrasonic endoscope probe body, the direction in which the shaft **5** projects to the outside of the motor **1** is opposite to the direction of the front end of the ultrasonic endoscope probe, such that the reflection surface of the end of the shaft **5** faces an ultrasonic vibrator. The ultrasonic waves radiated from the ultrasonic vibrator are reflected from the reflection surface, and the reflection surface is rotated and driven by the motor **1**, thereby performing scanning.

[0167] Even when the motor **1** is mounted in the ultrasonic endoscope probe, similar to the OCT endoscope probe, the electric power supply wires (flexible substrates **8** and **8**) are routed along the longitudinal direction of the ultrasonic endoscope probe. Accordingly, when the electric power supply wires are routed in the ultrasonic endoscope probe body, the electric power supply wires may not be bent. Therefore, it is possible to prevent disconnection of the electric power supply wires and to solve generation of R (corner R) of the bent portion generated due to bending. Accordingly, it is possible to suppress the increase in diameter of the ultrasonic endoscope probe and to shorten an inflexible portion of the front end of the ultrasonic endoscope probe. In addition, since the flexible substrates **8** and **8** are received in the cutouts **24** and **24** and are led out to the outside of the motor **1**, it is possible to prevent protrusion of the electric power supply wires (flexible substrates **8** and **8**) in the diameter direction of the motor **1**. Even in this case, it is possible to suppress the increase in diameter of the probe **15**.

[0168] Instead of that the reflection surface is not formed on the end of the shaft **5**, a motor in which the ultrasonic vibrator is fixed may be changed to be placed in the ultrasonic endoscope probe body. Even when such a motor is placed, the direction in which the shaft projects to the outside of the motor is opposite to the direction of the front end of the ultrasonic endoscope probe, such that the bending of the electric power supply wires is prevented when the electric power supply wires is routed. In addition, since the flexible substrates **8** and **8** are received in the cutouts **24** and **24** and are led out to the outside of the motor **1**, it is possible to prevent protrusion of the electric power supply (flexible substrates **8** and **8**) in the diameter direction of the motor **1**. Even in this case, it is possible to suppress the increase in diameter of the ultrasonic endoscope probe.

Second Embodiment

[0169] Hereinafter, a second embodiment of a motor and an OCT endoscope probe according to the present invention will be described in detail with reference to FIGS. **6** to **8**. FIG. **6** is a cross-sectional view of the motor according to the second embodiment. FIG. **7** is an exploded perspective view showing the structure of a stator of the motor of FIG. **6**. FIG. **8** is a schematic view of the internal structure of the endoscope

probe in which the motor of FIG. **6** is mounted and, more particularly, the OCT endoscope probe. In the description of the motor **18** according to the second embodiment, the portions overlapping with those of the motor **1** are denoted by the same reference numerals and the description thereof will be omitted or simplified. The stator of the motor **18** includes a housing **19**, a field coil **3**, a lead wire guide **20**, a flange **21** and flexible substrates **22** and **23**.

[0170] The appearance of the housing **19** has a substantially cylindrical shape and cutouts **24** and **24** are formed in an end thereof. Six lead wires **43** are lead out from the field coil **3**. A step **25** and three grooves **10** are formed in the lead wire guide **20**. In addition, the flange **21** inserted into and fixed to the end of the housing **19** also functions as the shaft bearing, and flat portions **26** and **27** are included in the outer circumferential surface thereof. In addition, the flexible substrates **22** and **23** are placed on and fixed to the flat portions **26** and **27** with the same configuration. A flange **28** is inserted into and fixed to another end of the housing **19**, to which the flange **21** is fixed, and the flange **28** also functions as a shaft bearing.

[0171] As shown in FIG. **6**, the field coil **3** is fixed to the inner wall of the housing **19**, and the lead wire guide **20** is placed on the side of the lead wires **43** of the field coil **3**. A rotor including a magnet **2** and a the shaft **5** penetrating through the center thereof is inserted into the field coil **3** with a gap interposed therebetween and is rotatably held by the flange **28** and the flange **21**.

[0172] In addition, the lead wires **43** are led out and routed in a space formed by the step **25** and the grooves **10** of the lead wire guide **20**, and a total of three tap wires and twisted wires which are neutral points are formed one by one. The tap wires and the twisted wires are connected to the flexible substrates **22** and **23** by a solder such that the lead wires **43** are connected to the outer circumferential surface of the motor **18**.

[0173] At this time, by filling the grooves **10** and the step **25** with an adhesive or the like, and adhering electric power supply lands **29** of the flexible substrates **22** and **23** and portions, in which the tap wires and the twisted wires are connected with a solder, with an adhesive or the like, a structure, in which disconnection is prevented without exerting overload on the tap wires and connection portions, is obtained, and fixing strength is increased. The field coil **3** and the lead wire guide **20** are received in the housing **19**, the flange **21** is inserted into and fixed to the end of the housing **19** while aligning the flat portions **26** and **27** at the positions of the cutouts **24** and **24**, and the flexible substrates **22** and **23** are received along the cutouts **24** and **24**.

[0174] The flexible substrates **22** and **23**, to which the lead wires **43** (the tap wires and twisted wires) are connected, are received along the cutouts **24** and **24** so as to be led out to the outside of the motor **18** without protruding from the outer diameter of the motor **18**. The direction in which the flexible substrates **22** and **23** are led out is equal to the direction in which the shaft **5** projects.

[0175] The motor **18** configured as described above is mounted in the OCT endoscope probe **15** shown in FIG. **8**.

[0176] The motor **18** is placed on a distal portion in the body of the OCT endoscope probe **15**. When the motor **18** is placed in the body of the OCT endoscope probe **15**, the direction in which the shaft **5** projects to the outside of the motor **18** is opposite to the direction of the front end of the OCT endoscope probe **15**. By placing the motor **18** as described above, the reflection surface of the end of the shaft **5** faces the end of the optical fiber **16**.

[0177] The light emitted from a light source (not shown) is propagated in the core of the optical fiber **16**, is emitted from the end of the graded-index optical fiber **17**, and is reflected from the reflection surface, the optical path thereof is changed by 90 degrees, and the light is irradiated to an organ, thereby forming an image. In addition, the reflection surface is rotated by driving the motor **18** so as to perform OCT scanning such that tomogram of an organ wall is acquired.

[0178] As described above, since the flexible substrates **22** and **23** are received along the cutouts **24** and **24**, the flexible substrates **22** and **23** are led out to the outside of the motor **18** in the direction, in which the shaft **5** projects, without protruding from the outer diameter of the motor **18**. Accordingly, when the motor **18** is mounted in the body of the OCT endoscope probe **15**, the flexible substrates **22** and **23** are routed along the longitudinal direction of the OCT endoscope probe **15**. Therefore, when the flexible substrates **22** and **23** are routed in the body of the probe **15**, the flexible substrates **22** and **23** may not be bent. Accordingly, it is possible to prevent disconnection of the flexible substrates **22** and **23** and to solve generation of R (corner R) of a bent portion generated due to bending. Therefore, it is possible to suppress the increase in diameter of the probe **15** and to shorten an inflexible portion of the front end of the probe **15**.

[0179] In addition, since the flexible substrates **22** and **23** are received in the cutouts **24** and **24** and are led out to the outside of the motor **18**, it is possible to prevent protrusion of the electric power supply wires (flexible substrates **22** and **23**) in the diameter direction of the motor **18**. Even in this case, it is possible to suppress the increase in diameter of the probe **15**.

[0180] In addition, since the flexible substrates **22** and **23** are received in the cutouts **24** and **24** and are led out to the outside of the motor **18**, it is possible to prevent protrusion of the electric power supply wires in the diameter direction of the motor **18**. Therefore, it is possible to suppress the increase in diameter of the probe **15**.

[0181] Since the flange **21** and the flange **28** function as the shaft bearings, it is possible to reduce the number of parts included in the diameter direction of the motor **18**. Therefore, it is possible to further downsize the motor **18** and the probe **15**.

[0182] In the electric power supply wire, instead of the flexible substrates **22** and **23**, for example, a lead wire or a leaf spring type connection terminal may be used. In addition, the connection between the lead wires **43** of the field coil **3** and the electric power supply wires may be performed by a connection terminal, instead of direct fixing using a solder, in the present embodiment. In addition, the probe **15** may be an ultrasonic probe or other probe, instead of the OCT probe.

[0183] The two flexible substrates **22** and **23** may be changed to be formed of one flexible substrate **22***a*, as shown in FIG. **21**, and the flexible substrate **22***a* may be led out to the outside of the motor **18**. Since the electric power supply wires are led out from only the outer circumference of one side of the motor **18** such that the number of electric power supply wires which become an obstacle at the time of scanning of the probe **15**, the rotation angle of the scanning shaft **5** is enlarged. As described above, the flexible substrate **22***a* may be also replaced with a lead wire or a leaf spring type connection terminal.

[0184] As shown in FIGS. **25** and **26**, at least a portion or whole of the two flexible substrates **22** and **23** may be changed to be formed of a transparent electrode material **46**

which is optically transparent. The portion of the flexible substrates **22** and **23** is the electric power supply wire portion placed on the optical path of the light reflected from the reflection surface of the shaft **5** which is a portion of the motor **18**. Accordingly, at the time of scanning of the probe **15**, the portion of the transparent electrode material **46** which does not overlap with the flexible substrates **22** and **23** is placed on the optical path of the reflected light. Therefore, it is possible to prevent the electric power supply line from becoming an obstacle at the time of 360-degree scanning of the probe **15**. As described above, the flexible substrates **22** and **23** may be replaced with a lead wire or a leaf spring type connection terminal. In addition, the electrical connection between the electric power supply lands **29** and the transparent electrode (ITO- or ZnO-based material) **48** may be performed as shown in FIGS. **28** and **29** or as shown in FIG. **30**.

[0185] As shown in FIG. **31**A or **31**B, a high transmissivity material in a wavelength region of the light propagating in the optical fiber **16** may be used as a reinforcing material **51** of the connection portion of the transparent electrode material **46**. The fixing of the reinforcing material **51** may be performed by an adhesive, an adhesion tape or the like, which is denoted by a reference numeral **52**.

Third Embodiment

[0186] Hereinafter, a third embodiment of a motor and an OCT endoscope probe according to the present invention will be described in detail with reference to FIGS. **9** to **11**. FIG. **9** is a cross-sectional view of the motor according to the third embodiment. FIG. **10** is an exploded perspective view showing the stator structure of the motor in FIG. **9**. FIG. **11** is a schematic view of the internal structure of an endoscope probe in which the motor of FIG. **9** is mounted and, more particularly, the OCT endoscope probe. In the description of the motor **44** according to the third embodiment, the portions overlapping with those of the motor **18** of the second embodiment are denoted by the same reference numerals and the description thereof will be omitted or simplified.

[0187] The motor **44** of the present embodiment is different from the motor **18** of the second embodiment in that the cutouts **24** and **24** are not formed and thus the appearance of a housing **45** has a substantially cylindrical shape. When the flexible substrates **22** and **23**, to which the lead wires (the tap wires and the twisted wires) are connected, are placed on the flat portions **26** and **27** provided on the outer circumferential surface of the flange **21** and the flange **21** is inserted into and fixed to the end of the housing, connection portions between the flexible substrates **22** and **23** and the lead wires are completely received in the housing **45** in the diameter direction of the housing **45**. The flexible substrates **22** and **23** are led out to the outside of the motor **44** without extending from the outer diameter of the motor **44** with certainty. The direction in which the flexible substrates **22** and **23** are led out is equal to the direction in which the shaft **5** projects. The motor **44** configured as described above is mounted in the OCT endoscope probe **15** shown in FIG. **11**.

[0188] As described above, since the flexible substrates **22** and **23** are completely received in the housing **45**, the flexible substrates **22** and **23** are led out in the direction, in which the shaft **5** projects to the outside of the motor **44**, without protruding from the outer diameter of the motor **44**. Accordingly, when the motor **44** is mounted in the body of the OCT endoscope probe **15**, the flexible substrates **22** and **23** are routed along the longitudinal direction of the OCT endoscope probe **15**. Therefore, when the flexible substrates **22** and **23** are routed in the body of the probe **15**, the flexible substrates **22** and **23** may not be bent. Accordingly, it is possible to prevent disconnection of the flexible substrates **22** and **23** and to solve generation of R (corner R) of a bent portion generated due to bending. Therefore, it is possible to suppress the increase in diameter of the probe **15** and to shorten an inflexible portion of the front end of the probe **15**.

[0189] In the present embodiment, since the flat portions **26** and **27** are formed on the outer circumferential surface of the flange **21**, a space is formed between the inner circumferential surface of the housing **45** and the flat portions **26** and **27**, and the flexible substrates **22** and **23** which are the electric power supply wires are placed in the space, it is possible to prevent protrusion of the electric power supply wires in the diameter direction of the motor **44**. Therefore, it is possible to suppress the increase in diameter of the probe **15**.

[0190] The two flexible substrates **22** and **23** may be changed to be formed of one flexible substrate **22***a*, as shown in FIG. **21**, and the flexible substrate **22***a* may be led out to the outside of the motor **44**. Since the electric power supply wires are led out from only the circumference of one side of the motor **44** such that the number of electric power supply wires which become an obstacle at the time of scanning of the probe **15** can be reduced, the rotation angle of the scanning shaft **5** is enlarged. As described above, the flexible substrate **22***a* may be also replaced with a lead wire or a leaf spring type connection terminal.

[0191] As shown in FIGS. **25** and **26**, at least a portion or whole of the two flexible substrates **22** and **23** may be changed to be formed of a transparent electrode material **46** which is optically transparent. The portion of the flexible substrates **22** and **23** is the electric power supply wire portion placed on the optical path of the light reflected from the reflection surface of the shaft **5** which is a portion of the motor **18**. Accordingly, at the time of scanning of the probe **15**, the portion of the transparent electrode material **46** which does not overlap with the flexible substrates **22** and **23** is placed on the optical path of the reflected light. Therefore, it is possible to prevent the electric power supply line from becoming an obstacle at the time of 360-degree scanning of the probe **15**. As described above, the flexible substrates **22** and **23** may be replaced with a lead wire or a leaf spring type connection terminal. In addition, the electrical connection between the electric power supply lands **29** and the transparent electrode (ITO- or ZnO-based material) **48** may be performed as shown in FIGS. **28** and **29** or as shown in FIG. **30**.

[0192] As shown in FIG. **31**A or **31**B, a high transmissivity material in a wavelength region of the light propagating in the optical fiber **16** may be used as a reinforcing material **51** of the connection portion of the transparent electrode material **46**. The fixing of the reinforcing material **51** may be performed by an adhesive, an adhesion tape or the like, which is denoted by a reference numeral **52**.

Fourth Embodiment

[0193] Hereinafter, a fourth embodiment of a motor and, more particularly, a geared motor in which a gear head is mounted, and an OCT endoscope probe according to the present invention will be described in detail with reference to FIGS. **12** to **16** and **20**. FIG. **12** is a cross-sectional view of the geared motor according to the fourth embodiment. FIG. **13** is a cross-sectional view taken along line A-A of FIG. **12**. FIG. **14** is a shaft perspective view showing a pinion formed on an

end of a shaft of the motor. FIG. **16** is a schematic view of the internal structure of an endoscope probe in which the geared motor of FIG. **12** is mounted and, more particularly, an OCT endoscope probe. FIGS. **20**A and **20**B are partial enlarged views of an end of an output shaft of the geared motor of FIG. **12**. The same portions as the first embodiment are denoted by the same reference numerals and the description thereof will be omitted or simplified.

[0194] In FIG. **12**, the geared motor **30** includes a motor **1** and a gear head **31**. In the drawings, a reference numeral **1** denotes the motor and a reference numeral **31** denotes the reduction gear head driven by and connected to the motor **1** via a pinion **32** formed on the shaft **5**. In the present embodiment, the structure of the motor **1** is any one of the structures of FIGS. **1**, **6** and **9** (in FIG. **12**, for example, the motor **1** of FIG. **1** is shown).

[0195] In FIGS. **12** and **14**, the pinion **32** having an outer diameter equal to or less than that of the shaft **5** is integrally formed on an end of the shaft **5**. Generally, the pinion **32** is formed by performing cutting such as hobbing, rolling, or the like to the shaft **5**, but the pinion **32** can be formed by the other suitable method, for example, a method of adhering a member, in which the pinion is formed, to the front end of the motor shaft.

[0196] If the shaft **5** is subjected to the cutting or the rolling so as to form the pinion **32**, a member for the shaft **5** formed of a round bar such as stainless steel is subjected to centerless machining so as to adjust outer diameter precision and surface roughness, the pinion **32** is formed on the end thereof by the cutting, the rolling or the like, and the shaft **5** including the pinion **32** is finished by heating treatment, barrel polishing treatment or the like. In addition, a position where the pinion **32** is formed may not be necessarily the extremity of the shaft **5**.

[0197] In the present embodiment, the outer diameter of the pinion **32** is equal to or less than that of the shaft **5** in order to decrease the diameter of the pinion so as to obtain a large reduction ratio. The lower limit of the outer diameter of the pinion **32** is not specially limited, but is preferably at least 80% of the outer diameter of the shaft **5** in view of strength.

[0198] The reduction gear head **31** includes a housing **33**, a reduction gear mechanism **34** driven by and connected to the pinion **32**, and an output shaft **35** placed on the output side (front end side) such that the rotation thereof is freely supported on a shaft bearing **11**. The pinion **32** is engaged with an initial stage gear of the reduction gear mechanism **34**. The structure of the reduction gear mechanism **34** included in the reduction gear head **31** is arbitrarily set and various mechanisms may be applied. However, in the present embodiment, a planetary gear reduction mechanism is used. The basic structure of the planetary gear reduction mechanism includes two sets of independent carrier units **36***a* and **36***b* sequentially placed from the side of the motor **1** to the side of the output shaft **35** and a set of carrier units **36***c* formed on the base end of the output shaft **35**.

[0199] Each of the carrier units **36***a* and **36***b* includes a plate-shape carrier **39**, in which three shaft portions **37** for supporting the planetary gear protrude on the surface of the side of the motor **1** in a circumferential direction at an interval of 120° and a sun gear **38** protrudes on a central portion of the surface of the side opposite to the motor **1**, and planetary gears **40** of which the rotation is freely supported on the shaft portions **37** (planetary gears **40** placed in the circumferential direction at an interval of 120°). The carrier unit **36***c* includes a plate-shape carrier **39***c*, in which three shaft portions **37***c* for supporting the planetary gear protrude on the surface of the side of the motor **1** in the circumferential direction at an interval of 120° and the output shaft **35** is fixed to the base end (or integrally formed with the base end) on the central portion of the surface of the side opposite to the motor **1**, and a planetary gear **40***c* of which the rotation is freely supported on the shaft portions **37***c*. An internal gear **41** is formed on the inner surface of the housing **33** in which the reduction gear mechanism **34** is placed.

[0200] As described above, the planetary gears **40** and **40***c* of the carrier units **36***a* to **36***c* are engaged with the internal gear **41**, the sun gear **38** of the carrier unit of the side of the motor **1** is engaged with the three planetary gears **40** and **40***c* of the carrier unit of the side opposite to the motor **1** in the adjacent carrier units, and the pinion **32** formed on the shaft **5** of the motor is engaged with the three planetary gears **40** of the first stage carrier unit **36***a*. Accordingly, the rotation of the pinion **32** is sent to the output shaft **35** via the three carrier units **36***a* to **36***c*.

[0201] In the geared motor **30**, as shown in FIGS. **12** and **20**, the end of the output shaft **35** is obliquely cut to the axial direction of the output shaft **35** such that the end of the output shaft **35** is obliquely formed to the axial direction of the output shaft **35**. The cutting angle Φ may be set to a desired angle by the requirement characteristics of the OCT endoscope probe in which the geared motor **30** is mounted. In the present embodiment, the cutting angle is, for example, 45 degrees.

[0202] In an obliquely formed surface **35***a* of the output shaft **35**, a reflective film **14** is formed (see FIG. **20**A) or mirror polishing is performed (see FIG. **20**B) such that a light reflection surface is formed. If the mirror polishing is performed, the obliquely formed surface **35***a* is mechanically polished so as to perform mirror finishing. In addition, if the reflective film **14** is formed, a metal film or a dielectric multilayer film with high reflectivity, such as aluminum, nickel, gold or silver, is formed on the obliquely formed surface **35***a*. As the film forming method, deposition, sputtering, CVD, plating, coating or the like may be used.

[0203] Alternatively, the overall output shaft **35** may be formed of amorphous metal alloy. By such a configuration, the reflection surface is formed of the amorphous metal alloy, but the surface roughness Ry of the reflection surface is set to 0.4 μm or less and more preferably 0.1 μm or less. By setting the surface roughness Ry to the above range, it is possible to prevent light reflection efficiency of the reflection surface from deteriorating.

[0204] As the amorphous metal alloy, amorphous metal alloy having at least one of elements such as Fe, Ni, Cu, Ti and Zr as main components is preferably used.

[0205] If the overall output shaft **35** is formed of amorphous metal alloy, the overall output shaft **35** is manufactured by injection molding. In particular, it is preferable that polishing is performed to a mold for molding the reflection surface and the mold surface roughness Ry is set to 0.4 μm or less and, more particularly, 0.1 μm or less, because the light reflection efficiency of the reflection surface after transferring is prevented from deteriorating as described above.

[0206] Alternatively, the light reflection surface may be formed in the obliquely formed surface **35***a* by combining the technical elements, for example, mirror-polishing the obliquely formed surface **35***a* of the output shaft **35** and forming the reflective film **14** on the obliquely formed surface

35*a*. In addition, the light reflection surface may be formed in the obliquely formed surface **35***a* by forming the overall output shaft **35** using amorphous metal alloy, setting the surface roughness Ry of the obliquely formed surface **35***a* of the output shaft **35** to 0.4 μm or less and forming the reflective film **14** on the obliquely formed surface **35***a*.

[0207] The outer diameter D of the motor **1** is set to about 2 mm as described above, but the outer diameter Dg of the gear head **31** is preferably set to be less than the outer diameter D of the motor **1**. This is because the electric power supply wires (flexible substrates **8** and **8**) led out from the motor **1** can be led to the outside of the motor **1** in the direction in which the output shaft **35** of the gear head **31** projects, without protruding in the outer diameter direction in the outer circumferential portion of the housing **33** of the gear head **31** and thus the increase in diameter of the probe **15** can be suppressed.

[0208] If the outer diameter Dg of the gear head **31** is set to be equal to the outer diameter D of the motor **1** or is set to be equal to or more than the outer diameter D of the motor, as shown in FIGS. **17** to **19**, electric power supply wire receiving grooves **42** and **42** may be formed in the housing **33** of the gear head **31**, the flexible substrates **8** and **8** may be received in the electric power supply receiving grooves **42** and **42**, and the flexible substrates **8** and **8** may be led out to the outside of the motor **1** in the direction in which the output shaft **35** of the gear head **31** projects. By such a configuration, even when the outer diameter Dg of the gear head **31** is set to be equal to or more than the outer diameter D of the motor **1**, it is possible to prevent protrusion of the electric power supply wires to the outer circumference of the gear head **31**. Therefore, it is possible to suppress the increase in diameter of the probe **15**.

[0209] The geared motor **30** configured as described above is mounted in the OCT endoscope probe **15** shown in FIG. **16**. The geared motor **30** is placed on the distal portion in the body of the OCT endoscope probe **15**.

[0210] When the geared motor **30** is placed in the body of the OCT endoscope probe **15**, the direction in which the output shaft **35** projects to the outside of the geared motor **30** is opposite to the direction of the front end of the OCT endoscope probe **15**. By placing the geared motor **30** as described above, the reflection surface of the end of the output shaft **35** faces the end of the optical fiber **16**. When the geared motor **30** is mounted in the body of the OCT endoscope probe **15**, the flexible substrates **8** and **8** are routed along the longitudinal direction of the OCT endoscope probe **15**.

[0211] Accordingly, when the electric power supply wires (the flexible substrates **8** and **8**) are routed in the body of the probe **15**, the electric power supply wires may not be bent. Accordingly, it is possible to prevent disconnection of the electric power supply wires and to solve generation of R (corner R) of a bent portion generated due to bending. Therefore, it is possible to suppress the increase in diameter of the probe **15** and to shorten an inflexible portion of the front end of the probe **15**.

[0212] If the motor **1** of the geared motor **30** is replaced with the motor **18** or the motor **44**, the two flexible substrates **22** and **23** may be changed to be formed of one flexible substrate **22***a*, as shown in FIG. **21**, and the flexible substrate **22***a* may be led out to the outside of the motor **18** or **44**. Since the electric power supply wires are led out from only the outer circumference of one side of the motor **18** or **44** such that the number of electric power supply wires which become an obstacle at the time of scanning of the probe **15** can be reduced, the rotation angle of the scanning output shaft **35** is enlarged.

[0213] In addition, the electric power supply wires, instead of the flexible substrates **8** and **8**, for example, a lead wire or a leaf spring type connection terminal may be used. Accordingly, the flexible substrate **22***a* may be also replaced with the lead wire or the leaf spring type connection terminal.

[0214] As shown in FIGS. **25** and **26**, at least a portion or whole of the two flexible substrates **8** and **8** may be changed to be formed of a transparent electrode material **46** which is optically transparent. The portion of the flexible substrates **8** and **8** is the electric power supply wire portion placed on the optical path of the light reflected from the reflection surface of the output shaft **35** which is a portion of the geared motor **30**. Accordingly, at the time of scanning of the probe **15**, the portion of the transparent electrode material **46** which does not overlap with the flexible substrates **8** and **8** is placed on the optical path of the reflected light. Therefore, it is possible to prevent the electric power supply line from becoming an obstacle at the time of 360-degree scanning of the probe **15**. As described above, the flexible substrates **8** and **8** may be replaced with a lead wire or a leaf spring type connection terminal. In addition, the electrical connection between the electric power supply lands **13** of the flexible substrates **8** and the transparent electrode (ITO- or ZnO-based material) **48** may be performed as shown in FIGS. **28** and **29** or as shown in FIG. **30**.

[0215] As shown in FIG. **31**A or **31**B, a high transmissivity material in a wavelength region of the light propagating in the optical fiber **16** may be used as a reinforcing material **51** of the connection portion of the transparent electrode material **46**. The fixing of the reinforcing material **51** may be performed by an adhesive, an adhesion tape or the like, which is denoted by a reference numeral **52**.

[0216] As described above, according to the present embodiment, since the end of the output shaft **35** of the geared motor **30** is formed by the light reflection surface, an optical part for a scanner, such as a mirror or a prism, is unnecessary in the end of the output shaft **35**. Accordingly, a space occupied by the scanner in the internal space of the front end of the probe can be eliminated and the inflexible portion of the front end of the OCT endoscope probe **15** can be shortened. In addition, the number of parts can be reduced.

[0217] Since the light reflection surface is directly formed in the end of the output shaft **35**, the optical path of the light after being reflected from the reflection surface can be set by desire and efficient light transmission to the subject can be achieved.

[0218] In addition, since a separate part such as the optical part for the scanner is not attached to the output shaft **35** of the geared motor **30**, it is possible to rotate the output shaft **35** with low torque and suppress the increase in size of the geared motor **30**. Accordingly, it is possible to suppress the increase in diameter of the overall OCT endoscope probe **15**.

[0219] By removing the optical part for the scanner, it is possible to reduce one axial shift element between the core axis of the optical fiber **16** and axis of the geared motor **30**.

[0220] By forming the reflective film **14** in the end of the output shaft **35** or performing mirror polishing, the light reflection efficiency of the end of the output shaft **35** is improved and thus light propagation efficiency is also improved.

[0221] Since the amorphous metal alloy does not have a crystal grain boundary, it is possible to improve surface smoothness of the reflection surface by forming the overall output shaft **35** using the amorphous metal alloy. Accordingly, since the amorphous metal alloy has a good mold transfer property in the injection molding process or a good polishing property in the polishing process, surface smoothness is excellent. As a result, the reflection efficiency of the manufactured reflection surface is also improved and the light propagation efficiency is also improved.

[0222] In addition, by mirror-polishing the obliquely formed surface **35***a* of the output shaft **35** and forming the reflective film **14** on the obliquely formed surface **35***a* so as to form the light reflection surface on the obliquely formed surface **35***a* or forming the overall output shaft **35** using the amorphous metal alloy, setting the surface roughness Ry of the obliquely formed surface **35***a* of the output shaft **35** to 0.4 μm or less and forming the reflective film **14** on the obliquely formed surface **35***a* so as to form the light reflection surface on the obliquely formed surface **35***a*, the obliquely formed surface **35***a* on which the reflective film **14** is formed is mirror-formed and the reflective film **14** is then formed. Accordingly, it is possible to further improve the reflection efficiency of the reflection surface.

[0223] The probe **15** may be an ultrasonic probe or other probe, instead of the OCT probe. When the geared motor **30** is placed in the ultrasonic endoscope probe body, the direction in which the output shaft **35** projects to the outside of the geared motor **30** is opposite to the direction of the front end of the ultrasonic endoscope probe, such that the reflection surface of the end of the output shaft **35** faces an ultrasonic vibrator.

[0224] Instead of that the reflection surface is not formed on the end of the output shaft **35**, a geared motor in which the ultrasonic vibrator is fixed may be changed to be placed in the ultrasonic endoscope probe body. Even when such a geared motor is placed, the direction in which the output shaft projects to the outside of the geared motor is opposite to the direction of the front end of the ultrasonic endoscope probe.

[0225] As described above, when the electric power supply wires are routed in the ultrasonic endoscope probe body, the electric power supply wires may not be bent. Accordingly, it is possible to prevent disconnection of the electric power supply wires and to solve generation of R (corner R) of a bent portion generated due to bending. Therefore, it is possible to suppress the increase in diameter of the ultrasonic endoscope probe and to shorten an inflexible portion of the front end of the ultrasonic endoscope probe.

INDUSTRIAL AVAILABILITY

[0226] The motor and the geared motor of the present invention are applicable to the endoscope probe in a medical field.

1. A motor comprising a magnet, a field coil, a housing, an electric power supply wire, and a shaft, wherein:

a lead wire led out from the field coil is connected to the electric power supply wire,

a cutout is formed in an end of the housing, and

the electric power supply wire connected with the lead wire is received along the cutout and led out to the outside of the motor in the direction in which the shaft projects.

2. A motor comprising a magnet, a field coil, a housing, a flange, an electric power supply wire, and a shaft, wherein:

a lead wire led out from the field coil is connected to the electric power supply wire,

a cutout is formed in an end of the housing, and

the electric power supply wire connected with the lead wire is received along the cutout,

a flat portion is formed on an outer circumferential surface of the flange, and the electric power supply wire is placed on the flat portion, and

the flange on which the electric power supply wire is placed is fixed to an end of the housing, and the electric power supply wire is led out to the outside of the motor in the direction in which the shaft projects.

3. The motor according to claim **1**, wherein flanges are respectively fixed to one end and the other end of the housing, and one or both of the flanges functions as a shaft bearing.

4. The motor according to claim **2**, wherein another flange is fixed to another end of the housing, to which the flange is fixed, and one or both of the flanges functions as a shaft bearing.

5. The motor according to claim **2**, wherein the electric power supply wire is led out from one side of the outer circumference of the motor.

6. The motor according to claim **1**, wherein at least a portion of the electric power supply wire is formed of a transparent electrode material.

7. The motor according to claim **2**, wherein at least a portion of the electric power supply wire is formed of a transparent electrode material.

8. The motor according to claim **1**, wherein:

the end of the shaft is obliquely formed to the axial direction of the shaft, and

a reflective film is formed on an obliquely formed surface of the shaft such that a light reflection surface is formed in the obliquely formed surface.

9. The motor according to claim **2**, wherein:

the end of the shaft is obliquely formed to the axial direction of the shaft, and

a reflective film is formed on an obliquely formed surface of the shaft such that a light reflection surface is formed in the obliquely formed surface.

10. The motor according to claim **1**, wherein:

the end of the shaft is obliquely formed to the axial direction of the shaft, and

an obliquely formed surface of the shaft is mirror-polished such that a light reflection surface is formed in the obliquely formed surface.

11. The motor according to claim **2**, wherein:

the end of the shaft is obliquely formed to the axial direction of the shaft, and

an obliquely formed surface of the shaft is mirror-polished such that a light reflection surface is formed in the obliquely formed surface.

12. The motor according to claim **1**, wherein:

the end of the shaft is obliquely formed to the axial direction of the shaft, and

an obliquely formed surface of the shaft is mirror-polished and a reflective film is formed on the obliquely formed surface such that a light reflection surface is formed in the obliquely formed surface.

13. The motor according to claim **2**, wherein:

the end of the shaft is obliquely formed to the axial direction of the shaft, and

an obliquely formed surface of the shaft is mirror-polished and a reflective film is formed on the obliquely formed

surface such that a light reflection surface is formed in the obliquely formed surface.

14. The motor according to claim **1**, wherein:

the overall shaft is formed of amorphous metal alloy,

the end of the shaft is obliquely formed to the axial direction of the shaft such that a light reflection surface is formed in an obliquely formed surface of the shaft, and

the surface roughness Ry of the reflection surface is set to 0.4 μm or less.

15. The motor according to claim **2**, wherein:

the overall shaft is formed of amorphous metal alloy,

the end of the shaft is obliquely formed to the axial direction of the shaft such that a light reflection surface is formed in an obliquely formed surface of the shaft, and

the surface roughness Ry of the reflection surface is set to 0.4 μm or less.

16. The motor according to claim **1**, wherein:

the overall shaft is formed of amorphous metal alloy,

the end of the shaft is obliquely formed to the axial direction of the shaft,

the surface roughness Ry of an obliquely formed surface of the shaft is set to 0.4 μm or less, and

a reflective film is formed on the obliquely formed surface of the shaft such that a light reflection surface is formed in the obliquely formed surface.

17. The motor according to claim **2**, wherein:

the overall shaft is formed of amorphous metal alloy,

the end of the shaft is obliquely formed to the axial direction of the shaft,

the surface roughness Ry of an obliquely formed surface of the shaft is set to 0.4 μm or less,

a reflective film is formed on the obliquely formed surface of the shaft such that a light reflection surface is formed in the obliquely formed surface.

18. A motor comprising a magnet, a field coil, a housing, an electric power supply wire, and a shaft, wherein:

a lead wire led out from the field coil is connected to the electric power supply wire,

a cutout is formed in an end of the housing,

the electric power supply wire connected with the lead wire is received along the cutout,

the motor further includes a reduction gear head,

a pinion is formed on an end of the shaft, and the gear head is driven by and connected to the motor via the pinion, and

the electric power supply wire is led out to the outside of the motor in the direction in which an output shaft of the gear head projects.

19. A motor comprising a magnet, a field coil, a housing, a flange, an electric power supply wire, and a shaft, wherein:

a lead wire led out from the field coil is connected to the electric power supply wire,

a cutout is formed in an end of the housing,

the electric power supply wire connected with the lead wire is received along the cutout,

a flat portion is formed on an outer circumferential surface of the flange, and the electric power supply wire is placed on the flat portion,

the flange on which the electric power supply wire is placed is fixed to an end of the housing,

the motor further includes a reduction gear head,

a pinion is formed on an end of the shaft, and the gear head is driven by and connected to the motor via the pinion, and

the electric power supply wire is led out to the outside of the motor in the direction in which an output shaft of the gear head projects.

20. The motor according to claim **18**, wherein the outer diameter of the gear head is less than that of the motor.

21. The motor according to claim **19**, wherein the outer diameter of the gear head is less than that of the motor.

22. The motor according to claim **18**, wherein:

a groove for receiving the electric power supply wire is formed in the housing of the gear head, and the electric power supply wire is received in the groove, and

the electric power supply wire is led out to the outside of the motor in the direction in which an output shaft of the gear head projects.

23. The motor according to claim **19**, wherein:

a groove for receiving the electric power supply wire is formed in the housing of the gear head, and the electric power supply wire is received in the groove, and

the electric power supply wire is led out to the outside of the motor in the direction in which an output shaft of the gear head projects.

24. The motor according to claim **18**, wherein:

the end of the output shaft is obliquely formed to the axial direction of the output shaft, and

a reflective film is formed on an obliquely formed surface of the output shaft such that a light reflection surface is formed in the obliquely formed surface.

25. The motor according to claim **19**, wherein:

the end of the output shaft is obliquely formed to the axial direction of the output shaft, and

a reflective film is formed on an obliquely formed surface of the output shaft such that a light reflection surface is formed in the obliquely formed surface.

26. The motor according to claim **18**, wherein:

the end of the output shaft is obliquely formed to the axial direction of the output shaft, and

an obliquely formed surface of the output shaft is minor-polished such that a light reflection surface is formed in the obliquely formed surface.

27. The motor according to claim **19**, wherein:

the end of the output shaft is obliquely formed to the axial direction of the output shaft, and

an obliquely formed surface of the output shaft is minor-polished such that a light reflection surface is formed in the obliquely formed surface.

28. The motor according to claim **18**, wherein:

the end of the output shaft is obliquely formed to the axial direction of the output shaft, and

an obliquely formed surface of the output shaft is minor-polished and a reflective film is formed on the obliquely formed surface such that a light reflection surface is formed in the obliquely formed surface.

29. The motor according to claim **19**, wherein:

the end of the output shaft is obliquely formed to the axial direction of the output shaft, and

an obliquely formed surface of the output shaft is minor-polished and a reflective film is formed on the obliquely formed surface such that a light reflection surface is formed in the obliquely formed surface.

30. The motor according to claim **18**, wherein:

the overall output shaft is formed of amorphous metal alloy, the end of the output shaft is obliquely formed to the axial direction of the output shaft such that a light

reflection surface is formed in an obliquely formed surface of the output shaft, and

the surface roughness Ry of the reflection surface is set to 0.4 μm or less.

31. The motor according to claim **19**, wherein:

the overall output shaft is formed of amorphous metal alloy,

the end of the output shaft is obliquely formed to the axial direction of the output shaft such that a light reflection surface is formed in an obliquely formed surface of the output shaft, and

the surface roughness Ry of the reflection surface is set to 0.4 μm or less.

32. The motor according to claim **18**, wherein:

the overall output shaft is formed of amorphous metal alloy,

the end of the output shaft is obliquely formed to the axial direction of the output shaft,

the surface roughness Ry of an obliquely formed surface of the output shaft is set to 0.4 μm or less, and

a reflective film is formed on the obliquely formed surface of the output shaft such that a light reflection surface is formed in the obliquely formed surface.

33. The motor according to claim **19**, wherein:

the overall output shaft is formed of amorphous metal alloy,

the end of the output shaft is obliquely formed to the axial direction of the output shaft,

the surface roughness Ry of an obliquely formed surface of the output shaft is set to 0.4 μm or less, and

a reflective film is formed on the obliquely formed surface of the output shaft such that a light reflection surface is formed in the obliquely formed surface.

34. An endoscope probe comprising the motor according to claim **1**, wherein:

the motor is placed in the endoscope probe body such that the shaft or the output shaft projects in the direction opposite to the direction of the front end of the endoscope probe, and

the electric power supply wire led out to the outside of the motor is routed along the longitudinal direction of the endoscope probe.

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